October, 1918

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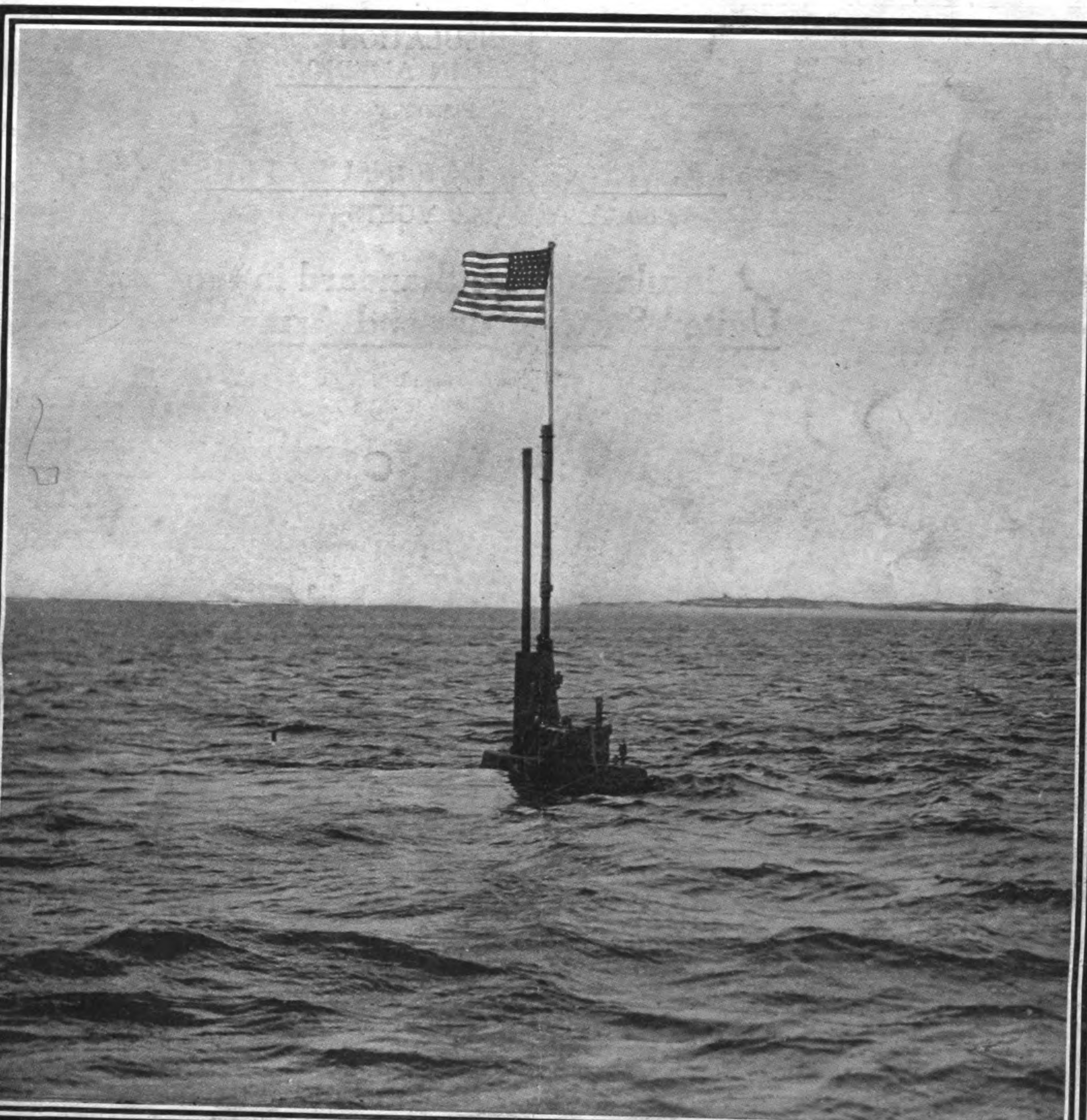
The WIRELESS AGE

Volume 6 Number 1



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The Wireless Age

Edited by J. ANDREW WHITE

Vol. 6 — Contents for October, 1918 — No. 1

Index of Equipment

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To Our Readers

THE new appearance of The Wireless Age, in the large size and lighter weight, is a step taken in co-operation with the War Industries Board to aid in the conservation of paper. It is also a step in advance, the first step for a broader editorial policy and a better magazine for our readers. The opportunities to display illustrations to better advantage is but one of the many merits of the new size; typographical arrangement and more equable division of features will also recommend it to readers. Then there is the editorial policy.

Since our country entered the war wireless work has been concentrated on war interests; since the beginning, and, in fact, even before the declaration of war, we have made the Age of direct practical value to readers who have gone into the service and those looking forward to a call to the colors. The progressive study courses in arts of war have been carefully followed by thousands of men with deep interest, and with appreciation, too, as shown by their letters. Entire Signal Corps battalions, from the Major down to the privates, including all men in the unit, have subscribed in bulk in order to get the detailed instructions given exclusively by this magazine.

Another draft of fighting men is in operation. The magazine's usefulness is thus further increased. While our Government for most excellent reasons now exercises a close censorship over the art, both as to operation and particularly as to military and naval developments at present, the time is not far distant when there will be a flood of most intensely interesting data marking marvelous advances in, and new applications of, the art of wireless.

Much new information, not in conflict with public policy, is ready for publication and our forthcoming issues will give you an insight into the principles and application of recent developments in the use of vacuum tubes as detectors, radio and audio frequency amplifiers, regenerative receivers, beat receivers and generators of radio frequency currents, together with applications of these tubes in wireless telephony.

The Wireless Age is the only medium through which wireless men can communicate to one another their ideas and inventions, and find out what is going on in the art during this extraordinary period.

HIGH-POWER STATIONS for trans-oceanic work, about which the layman knows little or nothing, will continue a live subject, handled, as in the past, by the engineers in charge of the Marconi system. The value of these exclusive articles is instanced by the detailed observations which have already been given of the power circuits, the control of currents from 300 k.w. alternators, the special antennae circuits for sending and receiving, amplified and made clear by data compiled in operation on both Atlantic and Pacific Coasts.

RADIO SCIENCE—This department is the most widely quoted source of wireless information among technical magazines. In it all developments of importance are recorded, both in mechanical advances made in design of apparatus and discoveries which establish new principles. The careful selection of subjects and the world-wide aspect of the research make this a distinctive and tremendously valuable feature. Representative of the best thought abroad and in the United States, it opens up new avenues for personal and patriotic experimental research, and will keep Age readers in advance of the recorded progress of the art.

PAN-AMERICAN STATIONS—The new commercial era dawning in Pan-America is demanding a wireless service spanning vast distances and for continuous operation. Extensive plans now being executed will be covered in exclusive articles containing descriptions and illustrations of the new wireless circuits and the opportunities the new services will create in the radio field.

EXPERIMENTERS' WORLD—By reporting in a broad way the latest advances in electrical and mechanical apparatus, this feature supplies an inspirational source for all electrical workers. Special attention is given to the contributions of readers, affording excellent opportunities for them to secure public recognition of meritorious work and for the exchange of ideas with all those of an inventive turn of mind. The remuneration for such contributions may readily become a source of income for carrying on further experimenting.

OPPORTUNITIES IN THE RADIO FIELD—Great commercial development in wireless telegraphy is bound to follow the world war. At the opening of the war there were approximately 700 land stations and 4,500 ship stations engaged in commercial service, military communication and the service of lightships and lighthouses.

Vast extensions have since taken place. Wireless is installed on thousands of vessels and all continents are now connected into a world-wide communication system which will be open for commercial service after the war.

There is an immediate demand for skilled radio men in military service, who will have a wide field of opportunity in future commercial and federal and local government service after the war.

You can use the opportunity presented in THE WIRELESS AGE to prepare for useful and remunerative work.

Government restrictions on newsstand distribution, to conserve paper supplies, make it desirable that each reader now subscribe for one year, sending subscriptions through their local newsdealer, or direct to us if more convenient.

THE PUBLISHER

VOL. 6. NO. 1. OCTOBER, 1918

THE WIRELESS AGE

WORLD WIDE WIRELESS

Wireless Telegraph and 'Phone for Lighthouses

GREAT BRITAIN is establishing on her coast radio lighthouses, equipped with combination wireless and phonographic instruments. These lighthouses are particularly valuable in thick weather, when the light is frequently invisible. The name of the lighthouse is repeated automatically by wireless every five seconds, the intensity of the sounds being so regulated that ships equipped with an ordinary wireless receiving apparatus will hear the signal the same approximate distance that the light could be seen in clear weather.

Skilled Radio Operators Needed in Tank Corps

SPECIAL opportunity to enlist in the tank corps, the only branch of service now open, is to be given drafted men between 21 and 31.

Men in deferred classification will be accepted, but none in Class 1 will be taken unless especially trained as a radio wireless operator or acetylene welder.

No person wearing glasses will be taken, and the minimum height and weight is 5 feet 6 inches and 130 pounds.

Blacksmiths, cooks, stenographers and wireless operators are especially desired.

Indications of the Growth of the Wireless Industry

IT IS well known to those engaged in the wireless art that few outsiders have any appreciation of the size of the industry. While many published accounts of increased use of radio appear in the newspapers and periodicals from time to time, the haze of romance which envelopes wireless seems to prevent these items from registering on the public consciousness. It is safe to say, for example, that the average business man would be greatly surprised to know that one branch of the military establishment purchased in a two weeks' period ending July 25th, the following wireless equipment: 9,500 complete wireless sets, 6,365 motor-generators, 20,000 sets of head 'phones, 10,000 antennae systems, 125,000 insulators, and great quantities of electrical supplies such as wave-meters, potentiometers and rheostats.

Considering the many branches of the army organization and that these purchases were for but a single branch, some idea may be gained of the quantities of equipment being made for the navy and merchant marine.

It is significant, too, that the report of the committee on education and special training announced at the same time that of 47,243 soldiers in the United States being given vocational training for service overseas, 6,693 were in the electrical class, engaged largely in radio operation.

Wireless Versus Long-Distance Cables

AT THE annual meeting of the English Marconi Company, Managing Director Godfrey Isaacs made the following statement:

"We have many important negotiations in many parts of the world of which it would not be wise of me to speak today, but I think one may fairly contemplate that the business of wireless telegraphy will be no less important when peace comes than it has been during the war. In speaking with a very eminent officer of the United States Navy Department a day or so ago, he told me that, although before the war he was of a very different opinion, he has now come to the conclusion that no new long-distance cables will ever again be laid; that, in his view, wireless telegraphy is thoroughly efficient for all telegraphic purposes. It would not be, perhaps, altogether advisable for me to express such views, but I think you will be glad to hear those of a practical man holding such an important position in so great and progressive a country as the United States.

Sykes in Philadelphia Evening Public Ledger. Copyright, 1918, by the Public Ledger Co.

"Lightning trained Yankees iss right"

German Clandestine Radio Apparently Silenced

GOVERNMENT agents now feel sure they have stopped all means of clandestine cable or radio communication between the United States and Germany.

After investigation they have found it takes usually four or five weeks for information published in this country to be published in Germany or Austria.

This is about the time required to carry newspapers or mail matter to Germany through the north European neutral countries. Repeated tests, officials say, have shown that important news reached the German government only through American newspapers, copies of which were actually carried to Germany or the adjoining neutral countries.

The Kaiser: Can't we make some of that American "Pep?"
Chemist: Not in an imperial laboratory, your majesty

Army's New Radio Schools Supplant French

TRAINING schools for radio work have been established by the division of military aeronautics at West Point, Ky., and Camp McClellan, Ala., field artillery firing centers, and instruction work along these lines will eventually be extended to Fort Sill, Okla., and Camp Jackson, S. C., and also to field artillery firing centers where observation schools of the division of military aeronautics are now working in co-operation with the artillery branch of the service.

These are only a few of the first steps in co-ordination that are now being instituted by the different branches of the service in the camps of this country. Heretofore advance schooling was to be obtained only when the American troops reached France.

Instruction in radio covers wireless communications between the fliers in the air and the gun crews on the ground below. By means of radio the fliers are able to signal for barrages, the location of batteries, ammunition dumps, infantry, trains, and other targets and also to "spot" for its own particular battery, which means to tell that battery whether its shells are landing to the right or left, over or under the target fired at.

Norway-American Wireless Link Forged

THE Farmand, a Norwegian trade journal, has the following article concerning the Stavanger wireless telegraph station: "The great wireless station erected near Stavanger by the Norwegian government for telegraphic connection with the United States has recently been completed. Trial messages have been exchanged between the station and the Belmar wireless station, near New York, and had the very best telegraphic results. The Stavanger wireless is one of the most powerful stations in the world and, as far as equipment is concerned, no doubt the one most up to date. The Norwegian-American direct telegraphic connection will afford considerable advantages to men of business on both sides of the ocean. Thus the wireless service will, according to the contract between the Norwegian Telegraph Department and the American Marconi Company, highly reduce the rates for telegrams between the two countries, and it will likewise save time for the business world, the station being of the duplex type and able to work in both directions simultaneously and at a higher telegraphic speed than attainable in the Atlantic cable service."

Torpedo Freak or Wireless Control?

WAS the Sommerstad sunk by a dirigible torpedo? The question was raised by the fact that after missing the steamer the deadly weapon swung about and this time struck. Capt. Hansen expressed no opinion, thinking that the swerve may have been due either to wireless control or to defective mechanism. Naval experts at Washington are said to ridicule the suggestion of wireless control, and explained that the mechanism can be so set that the torpedo will come back like a boomerang to the hand of the thrower. Thus set, they are quoted as saying, a torpedo becomes almost doubly effective, because if it fails to hit the mark it has a second chance.

Some of the reports, however, are not consistent with this theory, for they describe the torpedo as appearing to port, passing under the ship, circling with a radius of less than 100 feet, and striking the steamer on the port side where it was first seen. This might point either to a vagary of the mechanism or to wireless control, which occurs to everybody because so many inventors have been working for it, and with some measure of success. But if the Germans possess a really effective device of this sort, it will soon be made manifest; the cases which suggested dirigibility have been just frequent enough to make it probable that a new case is but one more freak of an automatic torpedo.

Antenna Springs for Minimizing Shock

ACCORDING to The Electrician of London, there has recently been patented an invention which reduces to a minimum the risk of wireless aerials on vessels being broken and the wireless apparatus thus put out of action when a ship becomes mined or torpedoed.

The invention is stated to be simple and inexpensive, and utilizes one or more long extension springs specially constructed and fitted at each end of the present aerials, these springs automatically extending and contracting to allow the aerial to lengthen or shorten to take up the varying distances between the top of the masts when they spring out of position through an explosion. These springs do away with the present necessity of lowering the aerial when a ship is being loaded, as they allow for the vibration of the masts caused by working the derricks, and their use would in some cases save the aerial being blown away by shell fire.

Secret Station Near Cartridge Works Discovered

A POWERFUL wireless outfit was seized at Bridgeport, Conn., on September 5th by army intelligence officers, following a two week vigil from the shelter of a cornfield. The plant was discovered on the upper floor of a house and had a sending radius of 150 miles.

A youth describing himself as Charles Mudry, 18, a wireless student, was arrested during the raid. He declared he received instructions from an older man. The plant, which is located next door to that of the Union Metallic Cartridge Co.'s factory, has been in operation over six months.

British Seaplanes Use Wireless Extensively

WHAT could be more natural than that the airman who forces the hidden power of the atmospheric air to maintain his craft aloft, should employ that same ether to carry his message to earth. There are other methods of communication, of course, but wireless telegraphy is predominant.

The wireless branch is a very highly specialized department, says Lieut. W. A. Robson of the Royal Air Force. Its work is of first importance.

At sea wireless is extensively used in connection with submarine chasing. Seaplanes, flying boats and airships carry out long patrols in co-operation with destroyers. Immediately the aircraft sight a U-boat the destroyers are informed by wireless of its exact location. This method is highly successful, for a submerged submarine which is invisible from sea level can be seen clearly from the air in good weather. It is a significant fact that every German submarine is fitted with an anti-aircraft gun.

Every pilot in the British air service must pass certain tests in wireless telegraphy before he is allowed to graduate; and in consequence at practically every home training station the air is made musical by the sound of many practice "buzzers."

Disabled Soldiers Taught Radio in Atlanta

THE most advanced work in the new science of "reconstructing" disabled soldiers is under way at Fort McPherson General Hospital 6, Atlanta, Ga.

Thirty different courses of instruction are given now to help cure sick men, to put them back into active service, or to begin their training for some vocation in civil life.

This hospital, created since we went to war, has an exceptional advantage in the re-education of disabled soldiers because the Fort McPherson reservation contains the great industrial shops of the quartermaster corps, which repair all kinds of army equipment.

More than 500 patients have taken curative courses of some kind—60 of them taking only light bedside or ward work; the rest going into classes that range all the way from newspaper reporting to farming.

Under the commandant of the hospital, Col. T. S. Bratton, the work is being carried on by Chief Educational Officer John L. Riley. He has 20 assistants, and many convalescents have trained to act as instructors.

Motor mechanics, telegraphy, radio, typewriting, mechanical drafting, sheet metal work, plumbing, stove repairing, steam fitting, blacksmithing, electric wiring and clerical work are some of the courses that are being given.

In many cases the men go back into certain branches of army work. A man who has lost a foot or a leg is just as valuable as a telegrapher as a whole man.

In other cases, he has laid the foundation for a trade through which he can earn his living in civil life.

Nauen Wireless Range Now 6,000 Miles

THE German wireless station at Nauen has been greatly improved since the outbreak of the war, says the Frankfurter Zeitung. Instead of a single transmission tower 300 feet high, it now has ten towers ranging in height from 890 feet to 360 feet, while the distance through which messages can be transmitted has been extended to 6,200 miles. The German paper is quoted as saying that the Nauen station's services have proved invaluable for instructing cruisers and U-boats and that both the Goeben and Breslau received through Nauen instructions to steam into the Bosphorus.

Tuthill in St Louis Star

Another Garabad motor

A New Japanese Long-Distance Station

THE installation of a new high power wireless system between Japan and the United States is actively engaging the Japanese department of communications. Officials announce that the project is a result in part of the very great congestion and delay in cable transmission which prevents the desired freedom of communication between Japan and the United States.

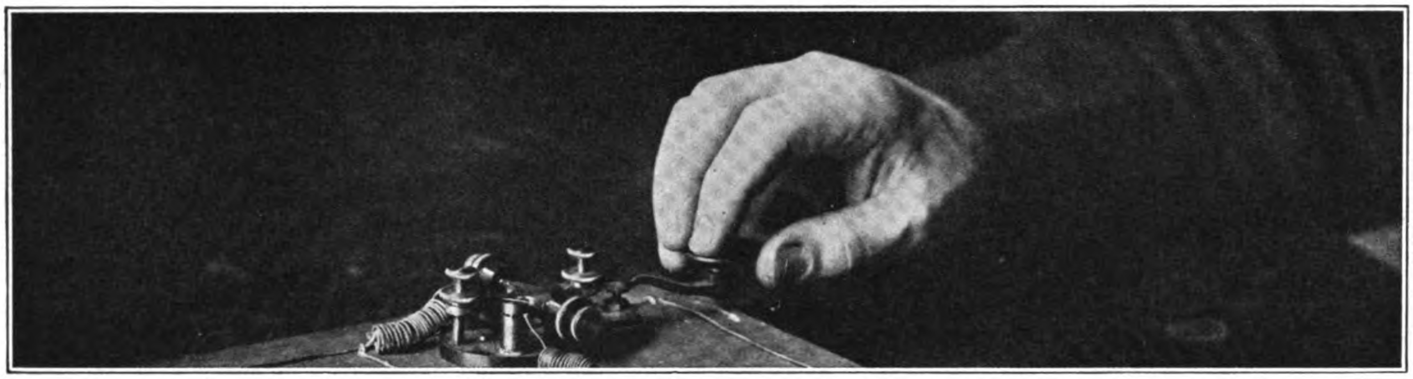
The present Japanese high power station communicated direct with the Marconi station in Hawaii. The proposed station will work with a station on the Pacific coast, the site of which probably will be near San Francisco, a distance of 4,600 miles. This will be one of the longest direct wireless services in the world. The estimated cost of a new wireless system is about $400,000.

While another cable linking the two hemispheres is desired, a line from Japan to Guam alone would cost $3,000,000. It is expected that details of the new wireless project will be announced shortly.

Compulsory Wireless Ordered By Greece

THE Greek Government has required wireless equipment on all passenger vessels of 300 or more tons dead weight capacity and on all cargo vessels of 1,000 or more tons.

(*Continued on page 36*)



The correct position for telegraphing, a matter of greatest importance to beginners

How Code Sending Is Taught

By Gordon Lathrop

Of the Marconi Institute

AMONG the batch of applicants for enrollment in the New York school of the Marconi Institute, on a Monday morning several months ago, were two young men who shall be named, for the purpose of this article, Dunbar and Baxter.

They came to the enrollment desk together. They aspired to become army aviators; each had just turned eighteen years of age. They lived within a few doors of each other in a Long Island suburb of the metropolis, had been classmates in the same prep school and were of the same social status—of clean, unaffected, all-American stock. The war-time spirit of each was equally high; the plans of their parents had been to send them to one of the great universities, but the boys had elected instead to enter the service of their country. In the Marconi Institute they expected to become proficient in the radio requirements demanded of all military aviators.

Their first day at the school found them memorizing the code in dots and dashes. They were told that each succession of dot or dash, or combination of dot and dash, produced a distinctive cadence which they must learn to recognize. They listened to the reproduction of Instructor Chadwick's sending contained in Victor-Marconi record No. 1. They learned the proper "grip" for sending. In the respects noted in the foregoing paragraphs the boys had points of contact in common. But here the resemblance ended.

Telegraphically, as indicated in their "form" in sending, these two students illustrated the extremes of faulty production of the signals. Land line telegraphers have the phrases "in the mud" and "in the air" to designate these two extremes. When sending comes to a receiving operator with scarcely recognizable distinction of dot and dash, with loose construction of components, in a heavy, "sticky" style, he says it is "in the mud." When it is too light, with "split" dots and unrhythmic relationship, one to the other, of the components, the sending is said to be "in the air."

"Pull it up," the receiver will demand when the sending is "in the mud." "Let it down" he will direct if the trouble is of the opposite nature.

Often the source of the trouble is in poor adjustment of the apparatus. A correct balance is then a matter of technical knowledge and skill. If, however, there is nothing wrong with the balance of the apparatus, the responsibility of making the correction rests with the sender. The writer, using Dunbar and Baxter as examples, hopes to indicate the way to achieve the happy mean which lies between the two erronenous extremes.

Because with both boys the trouble was largely temperamental, a description of each is necessary. Dunbar was shorter than Baxter, but heavier. He was sturdily set up; an ideal build for guard or center of a football eleven. Baxter was built like a sprinter, with slim waist and long legs. Nervous energy seemed to radiate from him. Dunbar, mentally as well as physically, was of less speed but greater endurance than Baxter. Dunbar's tendency was to think first, carefully and in detail, and act afterwards. Baxter, on most occasions, acted first and thought afterwards; fortunately his instincts guided the majority of his acts in the right direction. Dunbar's heavier features and slower manner of speech in contrast to Baxter's flashing animation suggested to an observer lessened dynamic force. But on better acquaintance Dunbar convincingly showed a potentiality fully as great as his more brilliant friend. Their service-rendering capacity—if that phrase may be used to measure intrinsic worth—was equal, but one was expressed in brilliant, forceful spurts, the other in steady, even-tempered plodding.

In precisely the ways indicated by the terms "in the mud" and "in the air" each boy began to produce the cadences of the dot and dash combinations in the beginners' room of the Institute. No doubt it would be absurd to state that an analysis of the sending style of a telegraphic aspirant will serve as an infallible guide to that aspirant's personality. In the cases of the two young men who are used here as illustrations, however, their strikingly opposite personalities were so accurately reflected in their opposite methods of faulty production of the code that the sketches of their personalities are worthy of note.

Dunbar's temperament, influencing his production of the code, caused him to cling to the idea that he had to visualize each letter in dots and dashes before he began to send it. He did this persistently, notwithstanding the instructor's efforts to induce him to conceive each signal rather as a cadence—of the letter "A," for example, as a staccato note and a legato note, occurring in quick succession, rather than to consider it as "dot" plus "dash." His mind's tendency toward inertia lost him the facility to adapt himself quickly to varying circumstances or unaccustomed processes of thought. The mind appeared to wrestle with his hand, wrist and arm; he produced the dots and dashes coarsely, heavily, "in the mud." He "let down" in the tension of the members which have to do with sending, or, better expressed, he failed to "pull up" with them sufficiently, so that he was continually without the proper "spring" of wrist and hand to make the immediate recovery of hand after each downward pressure. Physically, the focus point of trouble was in his wrist, the physical source of the trouble with nearly all poor senders. He couldn't seem to strike the correct degree of action at the wrist. His first impulse was to try to construct the signals with completely relaxed hand, with wrist barely clearing the table. That threw the responsi-

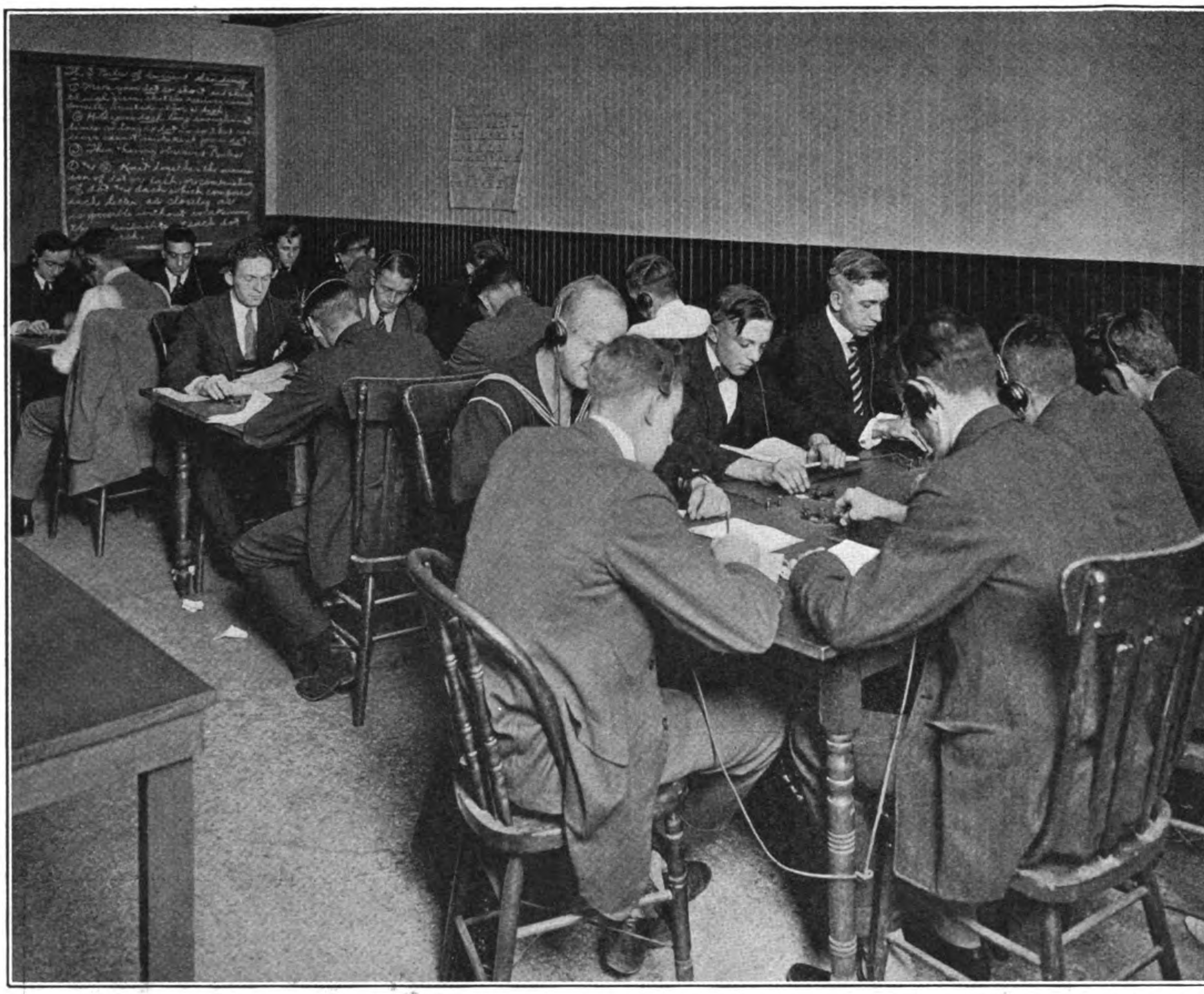
bility of making the downward pressures upon his fingers. He concaved his index finger and second finger and tried it that way with negative results. Then he would swing to the other extreme, stiffen his wrist and raise the under part three inches above the table. That is more than twice too high a position for the wrist, as it bows the arm at that point and necessitates a full arm motion. With his wrist at that position, Dunbar's production of the dots and dashes was with a ponderous, punching motion of the arm from the elbow, as impossible a method as that of the fingers alone. His sending was "in the mud," heavy, loose in construction, without individuality of each separate dot and dash and each separate signal.

Baxter had been keenly interested in his friend's struggles at the key. His quick mind had grasped at once the significance of conceiving each signal as a sound, to be dealt with in its entirety. His error was that he wanted to begin immediately at the fourth stage of the development of a sender, before he had mastered the first, second and third stages. He wanted to take up the morning newspaper and send page one before luncheon. The details which produce the proficiency to do that meant little to him. His temperamental impatience manifested itself immediately in his sending. Not having achieved that fine balance of hand, wrist and arm which comes from long apprenticeship at the key—which is necessary before one can send with speed and style, and endure—he called upon his abundance of nervous energy. He was not content to learn to make each downward pressure, whether a dot or a dash, with a distinct action of his wrist. He could not do this speedily enough. So he stiffened his wrist and hand, and drew on the nerves of hand and arm to make the dots. As is always the case in "nerve sending," most of the dots he made lacked substance. They were "split." His sending came jerkily, erratically. He would make a "V," for instance, with a speed of construction that would entail a pace of twenty-five words a minute to be in proper relationship to the other letters. Then he would make an "O," immediately following, perhaps, at a ten-word a minute pace. A plotted line of the progress of his sending would look like the trail of one of those loud-buzzing insects which dart this way and that, covering fifty feet to progress a straight line distance of ten feet. His style was up in the air; too tense, too highly geared, too light in substance and erratic in progress.

Physically, as with Dunbar, the focus point of trouble was at his wrist. There was nothing wrong with the position of thumb, index finger and second finger on the key knob. His hand made the proper, graceful curve on the key. His index finger was properly convexed when he began to send, and his second finger lay easily in place over the edge of the key knob. Third finger and little finger were curved without tension, clear of the key, to give his hand the proper balance. He proved to be a proficient telegrapher later, while the progress of Dunbar was slow and painful. The latter, in his mental make-up, was considerably more of the analytical type, without marked keenness of perceptions. Baxter's perceptions, on the other hand, were so keen that he was under continual temptation to exercise them to the neglect of his reasoning faculties. Telegraphically speaking, Dunbar was a trifle "in the mud," while Baxter was "in the air."

To correct the telegraphic errors of each, the instructors gave them "follow copy" practice, to register the sound of each letter in their minds, sending was arranged for half-hour periods at a time, then they were made to listen over and over to the Victrola reproduction of Mr. Chadwick's sending. That, with repeated corrections of the tendency of each to use a finger motion, instead of an up and down motion at the wrist, was all

This view of the northwest corner of the main code room of the Marconi Institute shows the students arranged at progressive tables according to the radio telegraphing speed they have acquired. The equipment provides for 250 students daily, all of whom are preparing for military service. Seated at the master table, right center, is the author, exponent of the physical and psychological study of pupils to determine the best method of correcting telegraphic errors



A corner of the beginners' room of the Marconi Institute, where men training for military service are made proficient telegraphers by the individual instruction plan. The practice sets are arranged in pairs, and as soon as the students acquire fundamentals, those with opposite faults take the paired keys and head telephones and spend hours sending to each other. In this way the faults of one are made plain to the other, and by discussion and practice each acquires flawless sending.

they could do. The burden of correction lay with the boys themselves through the experience gained from day to day.

* * *

In the beginners' room of the Marconi Institute the practice sets are arranged in pairs, a pair of keys and a pair of head telephones on a separate circuit. Until both boys had achieved a speed in receiving of six words a minute, they spent most of the hours of code practice sending to each other. There they worked out their telegraphic problem, in the same manner, no doubt, in which they have worked out other problems, of both less and greater importance than learning the code. One boy's faulty extreme was checked by the other, and a degree of balance was attained. Dunbar gradually "pulled up," while Baxter "let down." From the aviation ground school has come the report that Baxter's work at the front will probably be in a combat plane, while Dunbar's greater capacity for detail work has indicated that he will do better in a plane giving directions to the artillery.

Leaving the two young men at this point in the care of their instructors at the ground school, the writer will note what, in his opinion, are the necessary four stages of development to produce a first class sending telegrapher.

The first is when learning to construct each letter, numeral and punctuation mark in accordance with what he terms Rules 1, 2 and 3. They are:

"Make your dot so sharp and short, though firm, that the receiver cannot possibly mistake for a dash; make your dash long enough—three times as long as a dot—so that the receiver cannot possibly mistake it for a dot; knit together the components of each succession of dot or dash, or combination of dot and dash as closely as possible without weakening the individuality of each dot or dash."

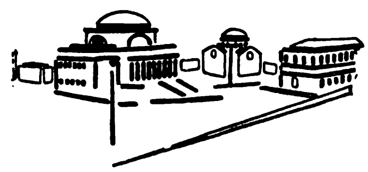
The second stage is when the sender is learning to make a succession of letters to compose a dictionary word, code word or a cipher combination in rhythmic steadiness.

The third is when he is building up strength and power enough of hand and wrist to endure the sustained strain of sending which practical telegraphy calls for.

The fourth is when he puts the final touches to his sending which produce style and speed.

That the word "speed" occurs but once in the outline of these four stages, and then as the last word, should be held significant, as the chief cause of the great number of mediocre and poor hand senders in both land line and radiotelegraphy is that "speed" becomes of too great importance in the telegrapher's mind before he has earned the right to use it.

Progress In Radio Science



Langmuir's Method of Constructing Gas-Free Electrodes for the Vacuum Tubes

IN order to obtain the exceedingly high vacuum so essential in connection with the operation of the vacuum tubes, it is necessary that the metallic elements inserted in the envelop be gas-free. Various methods have been described by which a cathode in a vacuum tube could be disintegrated so as to form a coating of metal on the inside of a glass bulb to act as one of the metallic elements, but in these processes there must necessarily be present a gas at a pressure of about 1 micron. Under these conditions the metal film is strongly adherent, and since a certain amount of gas appears to be fixed on the metal, it will consequently be given up, and prevent the emission of pure electrons from the filament.

Dr. Langmuir has recently shown a method whereby the anode of the vacuum tube consists of a coating of metal sprayed on the inside of the bulb by incandescing a refractory metallic conductor such as tungsten in a partial vacuum. To accomplish this the temperature must be sufficiently high to actively vaporize the refractory metal. This vaporized metal is deposited on the walls of the vacuum bulb as a hard strongly adherent film, which even when so thin as to be transparent, is a good electrical conductor, and capable of carrying relatively heavy currents. In fact Langmuir has described a three-electrode vacuum tube, in which an anode made in the foregoing manner was capable of receiving plate currents of 100 milliamperes or more.

In the tube shown in figure 1, one of the filaments can be employed as the cathode of a two-electrode vacuum tube, and the other to supply the vaporized metal for coating the interior of the tube. The device then becomes a two-electrode valve, and can be employed as an oscillation detector or as an ordinary rectifier.

The tube shown in figure 2 is essentially a three-electrode vacuum tube. Dr. Langmuir mentions that it is not necessary to supply an extra filament to be vaporized, but that the main filament 2 can be made large enough that part of its metal can be deposited on the inside of the bulb to act as the anode; in other words, the grid and filament of the vacuum tube are inserted during the original construction, but the metallic coating for the anode or plate is deposited by bringing the temperature of the filament up to a high degree of incandescence.

The process of manufacture is as follows:

Referring to figure 1, the envelop 1, consisting of glass, quartz or similar non-conducting material, is provided with two vaporizable conductors 2, 3, consisting of tungsten, tantalum, or molybdenum and provided, respectively, with leading-in conductors 4, 5 sealed into a stem 6 in the usual manner. One of these filaments 2, 3 may be used for the cathode of the completed apparatus and the other may be vaporized by heating it to incandescence by passage of current. The particles of vaporized metal travel outward in all directions in straight lines. In order to avoid the formation of a continuous conducting film over the entire inner surface of the container and in electrical contact with the cathode, provision should be made for intercepting the vaporized metal near the cathode so as to "cast shadows" on the envelop wall which will be free from deposited metal. This may be done by shaping the stem 6 so that it will in part bulge outwardly, also by providing knobs or rings on the leading-in wires as shown at 7, figure 1, or 8, figure 2.

The container is first exhausted to a good vacuum as may be obtained by means of a pump by chemical exhaust or other means, the envelop being heated during pumping to remove water vapor. The preliminary exhaust should reduce the pressure to one micron (0.001 m.m.) or less. The completion of the vacuum may be carried out by the active vaporization of a tungsten conductor in a side chamber by heating it electrically to about 2700° to 2900° C., preferably in the presence of a small amount of anhydrous pentoxide of phosphorus. The envelop is then sealed off, as indicated at 9, and one of the refractory conductors, for example, the filament 3 is heated to about 2700° to 2900° C. by passage of current, thereby depositing the desired gas-free film as indicated at 10. Contact is made to the film 10 of vaporized metal by sealed-in wires 11, two being provided to insure a good contact. This film is gas-free and so hard and coherent that even when no more than 10^{-6} m.m. in thickness it can only with the greatest difficulty be scratched off the glass with a knife.

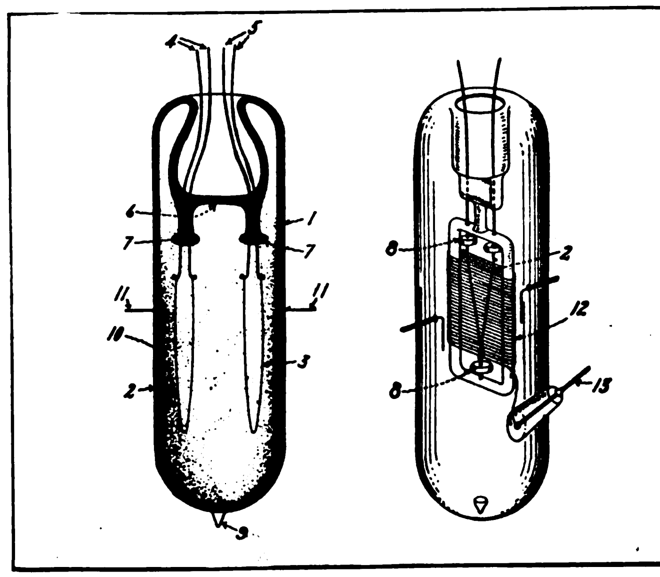


Figure 1 (left)—Tube which can be employed as an oscillation detector or as an ordinary rectifier
Figure 2 (right)—Three-electrode vacuum tube constructed by Langmuir's method

This device may be used as a relay by providing a discharge controlling grid 12, figure 2, connected to a leading-in conductor 13. In the device shown in figure 2 no separate conductor for producing the anode film has been provided, as the cathode 2 may itself serve to

provide the vaporized metal without serious damage when an extra heavy filament has been provided to serve as cathode.

Langmuir's Method for Preparing the Three Electrode Vacuum Tube

MUCH time and thought have been expended by various investigators in the preparation of the three-electrode vacuum tube to insure that previous and during the process of exhaustion the tube will be free of all air or occluded gases. Dr. Langmuir has previously shown in the Proceedings of the Institute of Radio Engineers, the construction of the three-electrode tube known as the pliotron, which he has been successful in developing. A recent modification of the construction of this tube is shown in figures 1 to 4 inclusive, figure 5 showing the use of the new tube in a particular circuit. Figure 1 illustrates an electron discharge tube completely assembled. Figures 2 to 4 inclusive show alternative forms of electrode grid construction in accordance with recent researches, figure 2 showing the construction of the cathode.

The cathode consists of a substantially straight filament 4 of highly refractory material, preferably tungsten, and provided with terminals 5 and 5′. The filament is attached to a light spring 6 between two oppositely disposed supports 7 and 8 constituting a frame-work, which is made of insulating material, such as glass or quartz. A number of turns of wire 9 are wound closely in such a way as to be out of contact with the hot cathode. This element constitutes the usual grid, which by means of an external potential exerts a static control upon the electron discharge of the tube. The anode is strung in a zig-zag manner over hooks 12 upon fork-shaped supports 13 and 14. The anode and the grid are preferably made of tungsten, but other gas-free metals may be employed.

One advantage of constructing the anode in this manner is that inasmuch as it makes a continuous conductor, it can be conveniently heated by the passage of a current during the evacuation of the tube, suitable terminals being supplied at 15, 15′.

It is not necessary for all purposes to provide connections for each end of the grid as shown, but it is desirable to do so when the potential applied to the grid is small and in the case of a straight or linear cathode the potential gradient along the grid may be made the same as that on the filament. In some cases this is of great advantage.

The connections of the new tube for use as an amplifier are shown in figure 5, in which a battery 18 supplies the heating current for the filament 4, and a battery 19 of the same voltage as battery 18, is applied to the terminals of the grid element 9, so as to produce a potential gradient along the grid the same as that along the filament. The current or potential which is to be amplified may be applied to the coil 20 which is connected between the grid and filament of the tube. A battery 21 may also be connected in this circuit to impress upon the grid a potential at which the device will amplify to its best advantage.

It is obvious that with this arrangement the difference of potential between any point on the cathode and the portion of the grid nearest thereto, will be the same along the entire length of the cathode. As usual a battery 22 connected between the plate and filament furnishes current for the operation of a telephone receiver 23.

In preparing the apparatus, the preliminary exhaust is carried out by methods such as used in incandescent lamp manufacture. The anodes are then subjected to an electron discharge or bombardment by impressing a suitable voltage between the cathode and anode. When the anode consists of a conductor such as wire 11, figure 1, it is preferably heated by passage of current either before or during the bombardment. If desired the grid 4 may also be heated during the evacuation of the device. When the anode is plate shaped heating may form part of the treatment by electron bombardment, the discharge current being made heavy enough to heat the anode. The voltage should be so chosen at the beginning of the electron dis-

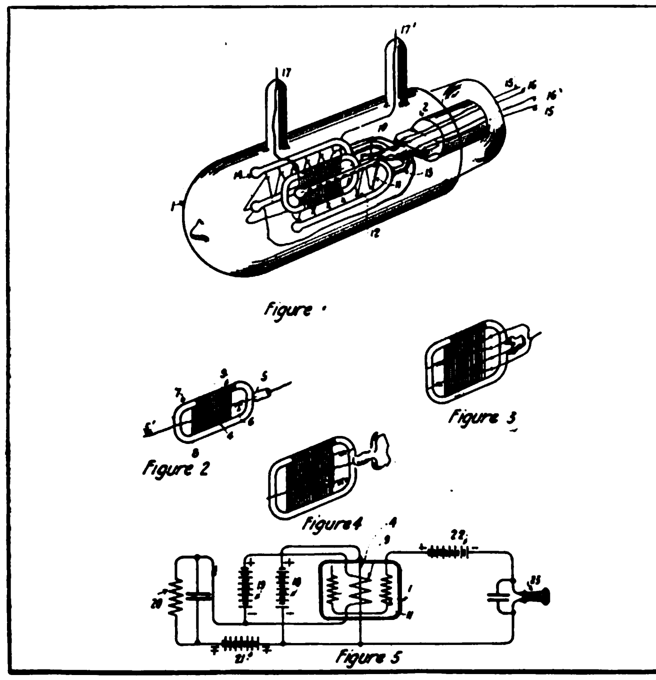


Figure 1—Electron discharge tube. Figure 2—Cathode. Figures 3 and 4—Two types of electrode grid construction. Figure 5—Use of tube in a circuit

charge treatment that blue glow is absent in the tube. This indicates the ionization of the residual gas by collision of gas molecules with electrons is taking place and under these conditions disintegration of the cathode is apt to take place. The discharge voltage is progressively increased, the gas being removed as fast as evolved, preferably by a Gaede molecular pump. This treatment is ordinarily continued until the discharge voltage is higher than the voltage at which the device is normally operated, but this rule will not hold true when the operating voltage is very high as substantially all the gas may be removed before the operating voltage is exceeded. Evacuation of the device should preferably be carried to a pressure as low as a few hundredths of a micron or even lower, although no definite limits may be assigned. In any event, the evacuation should be so low that no appreciable gas ionization takes place during normal operation. When the cathode and anode are very close together and the discharge is confined to a direct path, a greater gas pressure is permissible than when the opposite is true.

An electron discharge tube may be used in receiving systems for radio telegraphy. The passage of electron current across the evacuated space between cathode and anode is controlled by the static potentials impressed upon the grid. A tube prepared as described may be used to transmit currents limited in potential only by the dielectric strength of the glass, quartz or other material of the tube and the mechanical strength of parts subjected to static forces.

A Vapor Arc Generator for the Production of Radio Frequency Currents

BENJAMIN LIEBOWITZ has recently shown a novel apparatus for the production of oscillations of constant amplitude through the use of enclosed vapor discharge tubes. Two methods for use of this apparatus are shown in figures 1 and 2. In one form the apparatus consists of a vapor electric arc device having two cathodes

(*Continued on page* 39)

Torpedoed!

By Alfred S. Cresse

WHAT does the ominous word of the title mean to you? Press accounts usually tell of ships being sunk by giving brief data, such as the time, place and tonnage, leaving the fuller details to the imagination of the public.

Running through the U-boat blockade to allied ports has been an almost continuous job for me since the beginning of the war and I have met with varied experiences which have left within me no tender feeling for the Boche.

To give a clearer idea of what submarine sinkings mean I will tell of my experiences on board a torpedoed ship.

I was assigned as chief Marconi operator to the steamer Owasco. This vessel was formerly the Allemannia of the Hamburg-American Line, taken over by the United States Shipping Board, and loaded with a cargo of high explosives and gasoline for Genoa, Italy. We sailed from New York on November 17th for Norfolk, Va., to take on bunker coal for the voyage. We left Norfolk on the 23rd and had a rather uneventful voyage, arriving at Gibraltar thirteen days later. But Fate had yet to play her hand.

Two days after our arrival we left for Genoa with a convoy of three other merchant vessels with orders to run close to the coast of Spain. The first day everything ran clear; then, a few minutes before midnight, I heard a muffled explosion. I was on watch copying war warnings from a French station, so I quickly switched off the lights—a necessary precaution to be taken when opening a door or port while in the war zone—and looked outside. All was quiet. I returned to my work and called my assistant, Operator Decker, telling him what I had heard and advising him to dress quickly.

I had no sooner readjusted my receiver when a distress signal came in. I never received the name of the ship, for an instant later there was a deafening crash beneath us. The whole ship shook and trembled from stem to stern, and seemed to shudder at the death blow. Fixtures and fittings were torn from their bases and thrown to the decks. The wireless cabin was shifted several feet off its base.

A deafening explosion followed. The torpedo had entered the hatch forward of the bridge where the gasoline was stowed. Instantly the gas fumes exploded with great violence, blowing the hatch covering several feet in the air. A few seconds later flames were roaring out of the opening with a sound like one would expect from a gigantic blow torch.

The wireless transmitting apparatus was disabled by the explosion. I got this in what I considered temporary working condition, only to find that the current was cut off from the mains, when the wireless cabin was torn from its place.

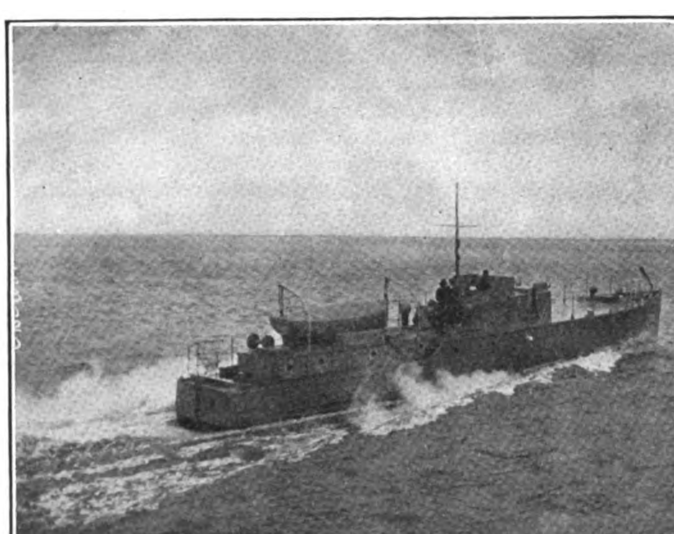
During the period when I was attempting to make repairs I had given little thought to the perilous situation. It was my job to get the set in working condition and flash out an S O S—that alone occupied my mind. Now, the roar of the conflagration penetrated my consciousness.

I decided to find the captain and consult him as to my next move. Upon going out on deck I found conditions much worse than I had expected. The canvas around the bridge was in flames and the ropes were blazing. The lifeboats had already been lowered. Apparently Decker and myself were the only ones left aboard.

We rushed to the starboard side and looked over. Number one boat was already lowered. I called to the captain, asking him if there was room for us; he answered that there was. Decker went first; leaping from the deck to the boat he fell a distance of about eight feet, then slid down into the boat. I followed in the same manner. We then pulled away from the side and lay off a safe distance. The ship was sinking fast on an even keel. Fourteen minutes after being struck the tops of her masts sank beneath the waves. All that remained

(*Continued on page* 18)

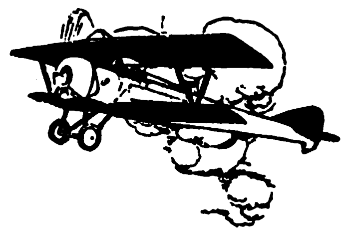
Operator Cresse's ship caught fire when torpedoed; the crew took to the boats before he arrived on deck



Returning home, on January 13th, a French submarine patrol was picked up off Bermuda. Twenty Frenchmen on board were near starvation

How To Become An Aviator

The Fifteenth Article of a Series for Wireless Men in the Service of the United States Government Giving the Elements of Airplane Design, Power, Equipment and Military Tactics



By J. Andrew White
and Henry Woodhouse

Instruction In Flying—First Flights

THE theory of aviation may now be said to be fully covered and the student ready for text on actual flight. If the preceding installments have been carefully studied there is no evolution of the airplane which is not entirely understandable to the reader. The function and operation of the airplane as a whole, and its controlling means as separate and unified parts, will be clear without further explanation in the description of the various flight maneuvers. One point may well be repeated here, however, to fix the matter clearly in the student's mind. That is the results of operation of the stick control and rudder, which may be simplified as follows:

To go down, push the stick control forward.
To rise, pull it back.
To tilt to the left, push it left.
To tilt to the right push it right.
To turn left, rudder with left foot.
To turn right, rudder with right foot.

Thus it is seen that the movements are the natural ones; for example, if the airplane is tilted sideways to the right the natural tendency is to lean left. Pulling the stick to the left rights the plane; and so on, each motion being the automatic one, so to speak.

During early stages of flight training the pupil must not hesitate to tell the instructor if at any time he feels physically or temperamentally unfit. Flying when not mentally inclined for the instruction will quickly ruin an aviator's prospects for later success, and any hesitancy about stating his condition for fear of a "cold feet" accusation is not to be tolerated. Aviation instructors and students are sympathetic, earnest men; they have no time for taunts.

Acquiring confidence in early stages is a tremendous help; until it is acquired the first solo flight should not be attempted; usually, after five hours dual-control instruction, the elementary machine may be flown solo. Some fifteen or twenty flight hours on various elementary types is generally sufficient, and the faster airplanes may then be used. Take-offs and landings should be frequent in practice, for nothing more quickly instills confidence than knowledge that the matter of alighting has been mastered.

TURNING

Turning with the novice almost invariably reveals one fault, i. e., the banking is too steep. This must be corrected before the aviator attempts the steep turns. The following general rules will prove useful in learning to turn the airplane correctly.

A good altitude margin should be allowed, so there will be at least 500 feet to correct for bumps or side-slips.

First turns should be very wide and not through more than 180 degrees, or half-turn.

While turning, speed should be kept up to at least level flying speed, and the airplane nosed down to its normal gliding angle. If flying speed is lost, the machine will side-slip or stall, getting into the cabré, or tail down, position which is dangerous to the novice.

As the natural tendency is to lose height, it is best to turn the airplane against the wind at first.

Aileron and rudder controls should be handled gently and first turns made gradual ones.

Figures 93 and 94 show turns improperly made. A turn too flat causes an outward side-slip, and too steep banking an inward side-slip. Either of these faults are perceptible to the aviator by the feel of the wind on his face. During a right turn, for instance, a noticeable wind on the opposite, or left, cheek indicates an outward side-slip. This is corrected by gently pushing the stick to the right for more bank or turning the foot bar for less rudder. When the opposite effect on the cheek is noticed, more rudder and less bank is required.

Gradually, turns may be made smaller until a 2½-turn spiral in 1,000 feet is accomplished. Turning while volplaning may then be tried.

In gliding turns the airplane's nose should be kept below the line of the horizon. Climbing turns require the nose of the machine above the horizon.

STRAIGHTENING OUT

A few simple rules will serve to teach how to come out of a turn properly.

Theoretically, the rudder and aileron controls are brought back to central positions. In many airplanes, however, they must first be brought over to the opposite bank and centered when the machine is level. The stick control should be moved a trifle sooner than the rudder, and brought past center, being returned to central position when the rudder is at center and the airplane at a horizontal level.

Coming out of a steep turn these control movements are made greater, the stick being given a semi-circular action. Special care should be taken that the rudder is not swung over opposite too early, for this will throw the nose of the airplane up and an inward side-slip will result.

S-TURNS

These are a series of descending Figure 8s or S-turns, useful for landing in a restricted area. Two rules should be followed. During the entire turn the aviator should keep his eye on the landing spot selected and always turn toward that point. The turns are made increasingly smaller as the ground is approached for the final glide.

Turning near the ground should be avoided; speed should be maintained by keeping the nose down.

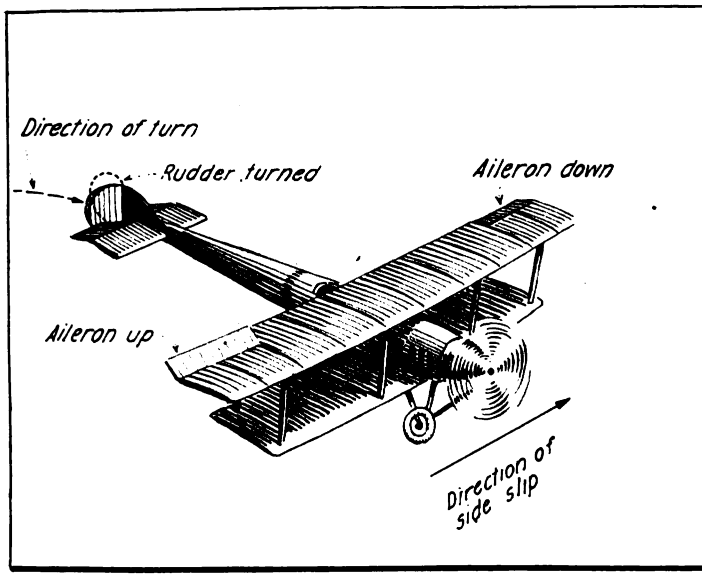


Figure 93—A too-flat turn, causing outward side-slip

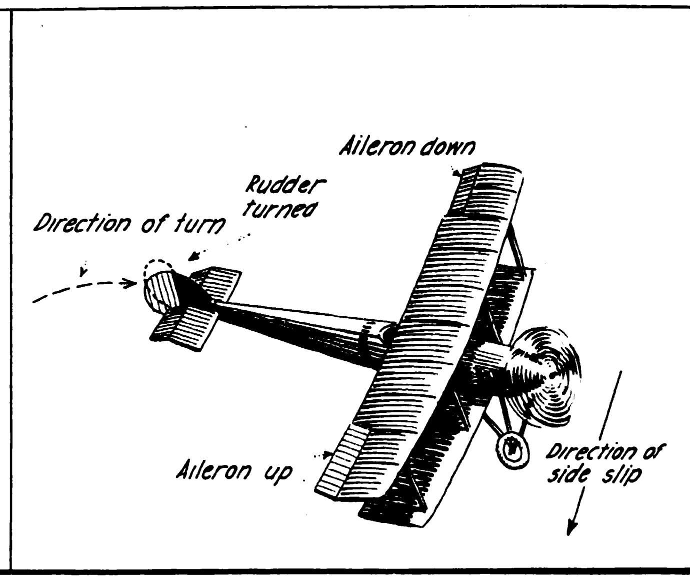


Figure 94—A turn too steep, causing inward side-slip

RIGHT OF WAY IN THE AIR

The student aviator should acquaint himself with the air rules of the flying school to which he is assigned. The courses are usually prescribed and the direction of circuits and pylon markings clearly stated. While slight variations may be encountered at various flying fields, the following general rules are almost universally observed:

MEETING AN AIRPLANE

When an airplane is encountered coming in the opposite direction, both machines keep to the right and pass at a minimum distance of 100 yards. See Figure 96.

OVERTAKING AN AIRPLANE

The faster machine coming from the rear maintains the same minimum distance, 100 yards, by steering clear, care being taken that the overtaking machine is not brought within the zone of influence of the backwash, for in the disturbed air rough going will be encountered. See Figure 95.

MEETING AT AN ANGLE

In a situation such as illustrated in Figure 97, where two airplanes approach at an angle, the aviator who finds the other machine on his right gives way.

LANDING SITES

The United States Army requires a flying field for testing aviators a minimum size of 800 by 100 feet. The general area of a field is about 9 acres, 200 yards square. Area allowances are added for obstacles, proportionately based on the obstacle's height, 12 times the height being added to the area, or 12 feet of field depth added for every foot of obstacle height.

The above regulation applies only to machines of slow landing speed. When fast airplanes are used, the 200-yard depth is added to as follows: 40 m.p.h., 60 yards; 45 m.p.h., 120 yards; 50 m.p.h., 360 yards; 55-60 m.p.h., 960 yards. These dimensions are based on landing and taking off against the wind.

Plowed fields, soft ground and ditches are dangerous to the inexperienced aviator and should be avoided as landing places.

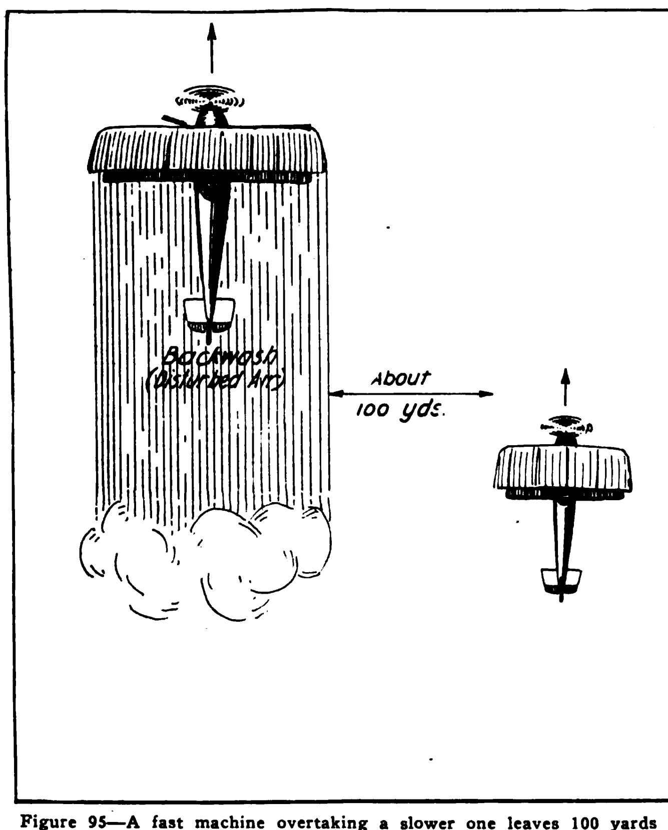


Figure 95—A fast machine overtaking a slower one leaves 100 yards interval between wing tips and avoids the backwash

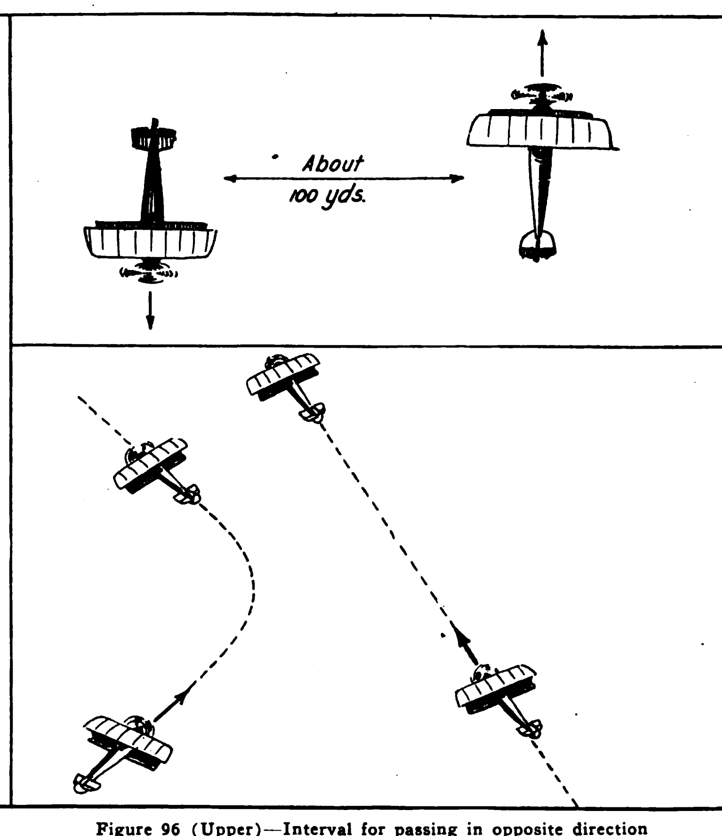


Figure 96 (Upper)—Interval for passing in opposite direction
Figure 97 (Lower)—Giving way when meeting at an angle

Canvas strips, 15 feet long and 3 feet wide, are usually employed to identify landing sites. These are visible to the pilot at altitudes up to 9,000 feet and indicate to the airman the direction for approach. The strips are arranged in the form of a T, the approximate outline of the airplane; a long strip is laid crosswise below the T to mark the point of contact with the ground, the machine being brought to full stop when on the T itself.

LANDING

Making a proper landing is one of the most difficult and most important tasks that confronts the student aviator. The success of the landing is largely dependent upon nosing the machine down at the proper distance from the landing field and choosing the proper gliding angle. Thus, if the angle is 1 in $6\frac{1}{2}$ and the machine is at 200 foot elevation the maximum distance allowed for the descent would be $200 \times 6\frac{1}{2} = 1300$ feet from the landing spot selected. If a greater distance is allowed, the machine is liable to fall short. A distance less than this maximum is preferred, since a spiral may be made to kill extra height and a correction of gliding angle made if the angle selected is not the best. All airplanes are designed to assume their gliding angle with power and thrust cut off.

OPERATION OF CONTROLS

When the descent is to be made the engine is throttled down to relieve strains on the airplane and insure flexibility of controls. Since the proper gliding angle is determined by the speed, the tachometer or the air speed indicator should register the determined speed within 5 miles an hour. The machine should be headed directly into the wind, the direction of which may be determined by observation of chimney smoke or flags below. When within 15 feet of the ground the tail control is gently pulled back, elevating the tail until the airplane is in its horizontal position for slow flight. This should be accomplished when 5 feet above the ground and the control then held; the airplane will thereafter descend without further assistance. The control should be held lightly, however, to correct for bumps.

When about to effect a landing a glance should be directed to the horizon or the indicator, and the aileron control used to keep the airplane laterally level. Swerving as the machine touches the ground is corrected by the rudder or the tail skid.

BAD LANDINGS

If when the airplane is about to land, it assumes the position of flight shown in Figure 99 it will bounce when it strikes the ground, the running gear breaking on the second impact. Also, if brought out of gliding position when too high off the ground it will drop, due to lack of speed, and the same break follow. These landings are known as the "pancake." The remedy is to speed up the motor to regain velocity and flying position, then throttle down and land.

The most dangerous landing is caused by failure to pull the airplane from gliding to flying position, the running gear striking the ground at a forward inclined angle. The motor must be instantly opened wide after the first bounce, flying speed being regained before the rebound.

A bad landing which severely strains landing gear and causes wheels to buckle, follows contact with the ground when the rudder is turned, causing a swerve, or when the airplane is not level laterally.

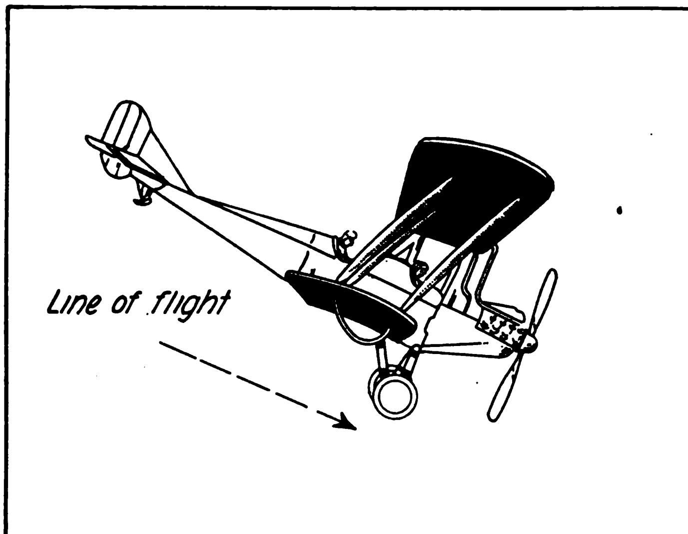


Figure 98—Airplane gliding to landing spot

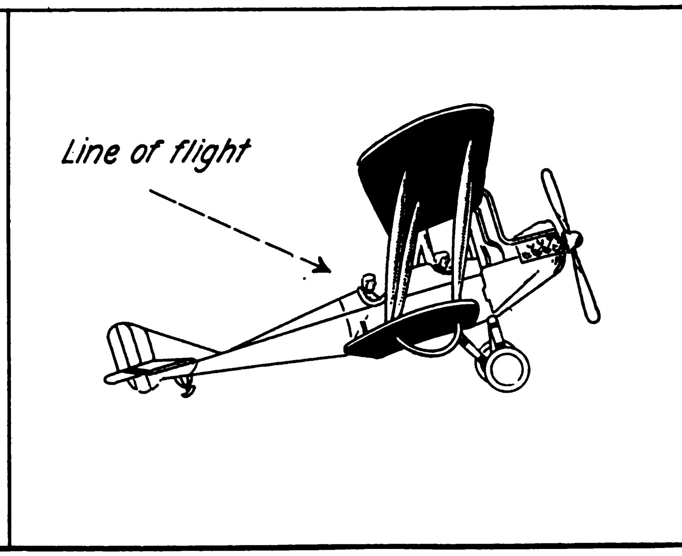


Figure 99—Incorrect landing position, resulting in "pancake"

Torpedoed!

(*Continued from page* 15)

was a large area of flaming gasoline marking the grave of another victim of German ruthlessness.

Distant explosions at frequent intervals informed us that there were other victims. We now began rowing toward a light on shore. There was a strong wind blowing against us, making rowing difficult and progress slow.

After two hours we beached our boat at Villa Joysa, a small Spanish fishing port, with a population of about eight thousand. Within the next half hour all the lifeboats, except one in charge of the third officer, reached shore. Local officials took us to a hotel where we were made as comfortable as possible under the circumstances.

None of us slept during the remainder of the night. About daybreak the crew of a Norwegian steamer, one of our convoy, arrived at the hotel. They, too, had been torpedoed. Later we learned that a British steamer, the third of our convoy, had met with a similar fate. The Germans had destroyed three of our number. The fourth was fortunate enough to escape.

In the early morning we were agreeably surprised by the arrival of the third officer with the rest of the crew. They had made for a different light and spent the night in a small village a short distance up the coast. After mustering the men it was found we had all survived with the exception of one sailor and a messman.

Later in the day the American Consul at Valencia sent his representative for us. We arrived at Valencia after dark and there we stayed until December 26th in rooms engaged for us by the Consul at the Pension Paris, an excellent hotel on the main street. Then we sailed on the steamer Manuel Calvo, of the Spanish trans-Atlantic Line, for New York via Malaga and Cadez.

Our adventures were not yet over. During the voyage we had extremely rough weather. The steering gear was disabled several times, and while this was being repaired we were in constant peril, being tossed about in the trough of the sea. It was at this time that several

(*Continued on page* 35)

Aviation News

There is a happy coincidence in the fact that Lieutenant Douglas Campbell, of Mount Hamilton and France, should have been the first American trained aviator to become an "ace." Campbell is the son of the famous astronomer who has served for years as chief of the Lick Observatory, presiding over the most powerful telescope in the world. It was in this aerie that the future ace grew to manhood. After receiving an education in California young Campbell went east and became a student in the Boston School of Technology. It is such training as this which turns out aviators equal to any in the world.

Lieutenant Douglas ("Doug") Campbell

Lieutenant Campbell is twenty-two years of age and has already received the much coveted Croix de Guerre. As a result of a recent successful encounter he also wears a wound stripe. He brought down his first boche on April 18, 1918. His record in air fighting has few equals. On the following day he bagged a second German, and a third on the 27th of the same month. An ace, it is hardly necessary to state, is an aviator who has downed five or more enemy airplanes in air encounters. It is not required that the enemy brought down should be actually killed, but there must be undisputed evidence that the enemy was brought down out of control.

One of Campbell's air battles was especially thrilling and attracted considerable attention even in France where such encounters are commonplace. He had engaged a German airplane at a high altitude. The boche soon got all that he wanted of the American's airmanship, and turning, beat an inglorious retreat. Campbell followed and was soon far over the enemy lines, which is always a hazardous thing to do. The battle was observed and five hostile airplanes joined in the engagement. By daring airmanship Campbell succeeded in shooting down one of these and making good his escape.

In a recent air battle Lieutenant Campbell was wounded, but he has already returned to active service. By the time this sketch appears our first American trained ace will probably have added new victories to his record.

* * *

The New York Times' special correspondent, in conclusion of the first authorized description of the work accomplished by the American forces since they landed in France, writes of visits he paid to several of the new American flying schools. He says:—

Colossal Flying Schools Abroad

"At another point some distance away I was equally impressed with both the work in progress and the working plans of one of the extensive so-called 'air service production departments.' This important centre of activity, which is typical of several now in course of construction, covers a tract of land over six miles long by a mile and a half wide, where the construction, assembling, testing, and repair of American airplanes will soon be going ahead full tilt on a scale never before known. The work splits into four main divisions—transportation, production, construction, and supply."

Lieut. Douglas Campbell, first American "Ace"

Trapshooting has been started for the benefit of the cadets at all aviation schools. The Government thus officially recognizes the value of a knowledge of trapshooting to the men who are training for this branch of the service. The most important part of their work will be shooting at a moving target, and trapshooting is designed to develop their skill in this direction.

Trapshooting for Aviators

* * *

A number of commissioned officers of the Aviation Section, Signal Corps, have just completed special courses in compass adjustment and air navigation. The Department of Military Aeronautics recently organized a school at Camp Dick, Dallas, Texas, for this advanced instruction. The two courses were conducted at the same time and completed in two weeks. The two British officers who were the instructors have expressed themselves as pleased with the results accomplished and the spirit of the men. Captain S. T. Fripp, Royal Air Force, was in charge of the compass classes. This course was designed to give engineer officers special instruction in the adjustment and compensation of airplane compasses. Those instruments get out of order because of the local magnetic field set up by magnetos and engines and from the jarring due to rough landing. The students who took this course were selected from graduates of the engineering ground officers' school at Massachusetts Institute of Technology. The course in navigation was conducted by Naval Instructor W. T. Farr, R. A. F. It consisted in instruction in air navigation, or flying by dead reckoning, the method of flying followed when the ground is not in view. Each of the flying schools in this country was represented in this course by an officer who had had charge of cross-country flying. The officers who finished this training will now return to their respective flying fields to instruct cadets in the subject.

Special Compass Courses

* * *

The Secretary of War authorizes the following:

With the concurrence of the President I have today selected Mr. John D. Ryan to act as Second Assistant Secretary of War in the place of Mr. Edward R. Stettinius, who is now in France. Mr. Stettinius will continue the special representative of the War Department in France, with full power to carry out special missions with which he is charged and will exercise as such special representative all the powers he has heretofore had.

John D. Ryan Made Air Service Director

Mr. John D. Ryan, as Second Assistant Secretary, is designated director of air service and is charged with the responsibility of procuring and furnishing to the Army in the field the matériel and personnel required for the air service, and is given supervision, control, and direction over the Bureau of Aircraft Production and the Bureau of Military Aeronautics with full power completely to co-ordinate their activities and to develop and carry out the air program.

The Post Office Department authorizes the following:

Cost of Operating Air Mail About Fifty Cents Per Mile

The first report of the comparative cost of the operation and maintenance of the Air Mail Service shows that the airplanes used in this service have broken all records for economy of gas consumption.

The total of all operating expenses of nine airplanes covering flights aggregating 7,234 miles, was $3,682. The total consumption of gas representing 113 hours and 8 minutes of flying was 1,377 gallons, which is $32.50 per hour—something over 50 cents per mile. The total cost of gas was $405 in flying 7,234 miles.

The best performance in flying was made by a Curtiss J-N-4 machine, which flew 26 hours and 40 minutes at a cost of $28.01 an hour and covered 1,719 miles at a cost of 43½ cents per mile. A plane equipped with an Hispano-Suiza 150 horsepower engine used approximately 8 gallons of gas per hour, and a plane equipped with a 400-horsepower Liberty motor used 17 gallons per hour. This shows 40 per cent less gas consumed than generally required for airplane engines of these sizes.

The calculation of operating cost includes departmental overhead charges, interest on investment, replacement of parts, deadhead time of mechanics, gas, lubricating oils, office force, motor cycles and trucks; rent, fuel, light, and telephone; pay of pilots, hangar men and mechanics.

The average consumption of gas for the nine planes was 12 gallons per hour.

* * *

The War Department authorizes the following:

Deaf Mutes Not Accepted as Flyers

The Division of Military Aeronautics has announced that applications of deaf mutes would not be accepted for war service in aviation and that directions have accordingly been issued to so inform hundreds of young men who have been encouraged to seek such enlistments.

The erroneous idea has apparently been deliberately circulated that since deaf mutes possessed little, if any, sensitivity of the inner ear, they would be little subject to dizziness, and, therefore, make good flyers. So persistently have these unauthorized statements appeared from time to time recently, that two separate investigations were started three weeks ago; one to determine the source of this misleading information and the other to make special tests of accuracy of deaf mutes in sensing motion.

The first investigation is not yet finished, but, so far, it is believed, that German propaganda is at the bottom of the agitation. The second investigation, completed by the Medical Research Laboratory at Mineola, L. I., included a number of tests during airplane flights to ascertain what effect, if any, the absence of the delicate balancing apparatus that exists in normal inner ears has upon persons who are without them.

At the Mineola tests the same plane was flown by the same pilots over the same course in each test. First, 10 normal men who had never flown were blindfolded, seated in planes, and told that after reaching a certain level the pilot would execute a number of evolutions which he, the passenger, was to record and to make particular note in which direction the plane had been turned to the right or left, up or down. The flights included stretches of level flying, climbing, left and right turns, dips and banks.

With very few exceptions the passengers with normal internal ears made correct notations of the different directions in which the pilots took them, noting each turn and dip correctly. Seven deaf mutes were then blindfolded, given the same instructions, and taken over the same course by the same pilots, to note the movements of the planes.

Being blindfolded, and minus, as they were, of the equilibrium of balancing organs in their ears, the deaf mutes failed to note changes of even as much as 90 degrees. Nor could they differentiate the deepest right from the deepest left banks, nor notice the difference between climbing or diving in a practically vertical position. Some of the passengers with normal ears, on the other hand, reported changes in direction as slight as 5 degrees, and were apparently sensitive to the slightest deviation.

After the tests, several of the deaf mutes admitted that they had been entirely in the dark as to their position while in the air.

* * *

The Aviation Program

A pamphlet has recently been issued by the Smithsonian Institution containing extracts from the Report for the year 1917, of the War Cabinet of Great Britain relating to supply of aircraft.

The description given of the difficulties in the way of obtaining a supply of aircraft is so accurate and is so general in its application to all countries that it is believed it should be given as wide a circulation as possible in America. Its application to the American aircraft situation is evident if we remember that Great Britain has been at war since August, 1914, and that every resource of the country, famous for generations as the center of mechanical developments, has been applied to the problem of the production of aircraft. This enables us to appreciate more clearly the progress made by the United States in 1917-18.

"It is rather the fashion to criticise the quality of our machines. Most of the critics, however, are ignorant of the technical and manufacturing difficulties which have to be overcome in order to keep up a constant and increasing supply of the most up-to-date machines. Not only are the technical difficulties and the resultant research and experimental work formidable in themselves, but the task of building up in war time, without seriously affecting the requirements of other services, a new industry of a most highly skilled character necessarily puts a heavy strain upon the organizing and manufacturing ability of the country.

"The science of aeronautics is in a state of constant and rapid development; improvements in engines, aeroplanes and their numerous accessories are constantly being worked out. But the interval between the discovery of an improvement and its introduction into the service is, owing to technical considerations, very much longer than is commonly supposed. Experience shows, that, as a rule, from the date of the conception and design of the aero-engine to the delivery of the first engine in series by the manufacturer, more than a year elapses: the corresponding period for an aeroplane is about one half as long. Consequently, plans have to be laid for a long period ahead, and these plans are liable to be upset by many uncertain factors. The hopes based upon the promising results given by the first experimental engines of a new design are frequently disappointed owing to difficulties of bulk manufacture or to defects only developed after long trial in the air; new types of aeroplanes favorably reported on when first tried are found on longer experience not to give complete satisfaction, and yet it is impossible, if we are to keep ahead in the keen struggle for aerial superiority, to wait for full experience before placing orders. Risks must be run, and new types must be adopted at the earliest moment consistent with reasonable assurance that they will constitute a substantial improvement on what is already in use. Orders must be placed, moreover, for considerable numbers and for delivery over many months, as the large output required for our present flying services can

(*Continued on page* 41)

Signal Officers' Training Course*

A Wartime Instruction Series for Citizen Soldiers Preparing for U. S. Army Service

By Major J. Andrew White

Chief Signal Officer, American Guard

Seventeenth Article—The Signal Corps and General Coast Defense

THE United States, unlike other great nations of the world, has never established, and may never need to establish, permanent fortifications on the land frontiers, since the real frontiers are the seas. But even without the obligation of defense against neighbors to the north and south, the vast extent of the coast imposes upon the country a duty which can but grow greater as population and wealth advance, and as the power and number of commercial ships and of navies increase. Types, speed, and size of ships are bringing alien shores yearly into more intimate relations and are making sea attack more easy, more swift, and more dangerous than ever before. The weight and range of floating batteries, the number and speed of merchant vessels and their great transporting power, the swarms of rapid and dependable auxiliaries, the submarine, the airplane, and the dirigible, leave all but strongly protected coasts without the chance of defense in war, except by airships and submarines and of course the mobile army, and fixed defenses in addition to a navy whose duty at the outset may call it into distant seas. The probability of the absence of the navy at the very moment when coast protection becomes most necessary is so strong as to amount to a certainty.

Regarding the defense of the seaboard of the United States, it appears clear in retrospect that the inertia which for years followed the close of the civil war and the later days of tranquility, prevented the making by the nation of any serious effort to protect the coasts of the country from foreign attack until some thirty years ago, when indifference began to give way to the demand for an efficient navy. The growth of the navy in turn emphasized the need of protected harbors and of permanent defenses; and as the fortifications required soldiers to man them attention was at last directed more and more strongly to the personnel of the defense. At last the coast artillery was given a working, if still a skeleton, organization; efficient armament and satisfactory equipment were added; systems of fire control and directions were devised and at least partial lines of information installed. Finally it began to be understood, though dimly at first, that defenses themselves must be defended; that the eyes and the hands of men must assist in coast protection and that two important factors of the defense, namely, the coast patrol and the mobile army; must form a front for any adequate system of protection.

For convenience in considering what follows, it is assumed that in war the coast defense, which combines the military and naval dispositions and operations necessary to resist attack on any part of the coast line, may be divided into six factors, each related to the other in operation and all dependent upon co-ordination of action to bring out their full value. These are, first, the fixed and floating defenses of the artillery, consisting of the armaments, submarine defenses and materials, coast and scout ships, and to some extent air craft, torpedo, submarine, patrol, and picket boats; the personnel, including all troops assigned to duty in connection with the fixed defenses. Second, the general defense troops of the regular or volunteer army, or of the organized militia, not including the supports of fixed positions. Third, the air service, including the necessary aero squadrons of various types, with their auxiliary tractors and the dirigible when used for coast patrol and defense. Fourth, the coast patrol, including the coast guard. Fifth, the service of the lines of information; that is, the Signal Corps of the army. Sixth, the navy.

Although each of these factors supplements the others, it is evident that the one which binds them all into a working whole, and without which the other five will have rather less cohesion and connection than so many reeds shaken by the wind is the Signal Corps in control of the lines of information and the service of air craft.

To arrive at a proper understanding of the extent and character of the lines of information necessary to keep in brain touch the elements of the defense of a great seaboard like our own, it will be well to first outline the general scope of the defense and to indicate the part played by the other factors in war.

The first of the factors of defense to be considered is that of the fortified positions.

In general terms, the permanent defense of a coast or harbor consists in the adequate protection of a number of distinct positions, which from their importance to the country or value to the enemy must be guarded against injury, occupation, or capture. Such positions are either actually or potentially guarded permanently by a number of fixed artillery emplacements, the fighting or tactical units of which constitute a chain of command. The artillery defense as a whole is made up of a series of tactical areas, each measurably complete and independ-

*The articles in this series are abstracted from the complete volume, "Military Signal Corps Manual," by the same author.

ent in itself, but separated usually by considerable distances of coast from the others, and the whole kept in touch by lines of information, usually commercial, which form a chain encircling the country.

On the coasts of the United States there are eighty-one separate forts where modern defenses are installed or are in process of installation; in the Philippines there are six; in Hawaii, four; in the Canal Zone, five; a total of ninety-six. It is evident, therefore, that the fixed defenses alone required a vast number of lines of information and, further, that for the purpose of control of its vast coast line these positions must be kept in communication not only with great centers of population and with the capital of the country but with each other, and that under certain probable conditions of war the chain of defense from Portland to Galveston, from San Diego to Puget Sound, or perhaps from Quoddy Head to the Straits of Fuca, must be kept in constant and immediate touch by telegraph, telephone, or radio. This, of course, is largely a problem for the existing commercial lines to solve.

The Mobile Army of Coast Defense

It is probably evident to all who have considered the matter that the most necessary factor of the land defense of the coast is the mobile army, together with its auxiliaries. Even to the unthinking it must be obvious that without such forces there can be no real and substantial protection for the coasts, except at those positions which have been selected beforehand for fortification, which of necessity will be few in number. Even if these fixed defenses could stand alone, which they cannot do, they will of necessity form but a partial and interrupted protection to an extended seaboard and will leave open to attack many important towns, serviceable harbors, and landing places that may be used by an enemy as a base or as coaling and supply stations. The fortified positions are really harbor defenses only. It is clear also that a country with some 5,700 miles of coast line offered to attack, indented with innumerable minor harbors and anchorages and dotted with important towns that invite destruction, cannot protect all its vulnerable points by costly and extensive armaments; as a consequence, minor positions must be otherwise defended or left to shift for themselves. While the defending navy remains within reasonable distance of the coast the minor positions will be free from danger, but a navy, if efficient, will not remain at home. In a serious war, therefore, protection for the less important positions must fall to the care of such of the floating defenses as may be withheld from distant seas; to the troops of the mobile army, aided by such land batteries as can be hastily constructed and armed; to the submarine and to the air craft. Such partial defenses may not prevent attack and local injury, but they can, at least, prevent destruction and an occupation that may provide the enemy with a naval base and perhaps threaten invasion of the country at large. Protection against this danger rests with the mobile army alone, once a foothold has been established on our coast.

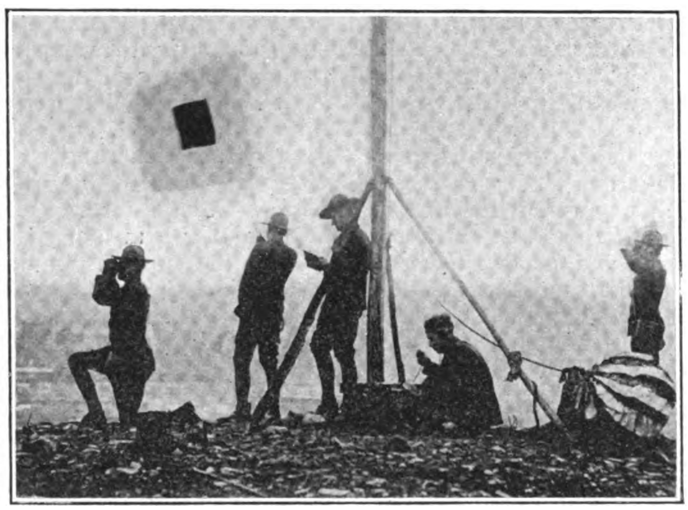
The need of a mobile army in coast defense is not, however, confined to the protection of the lesser positions and harbors unprovided with effective fortifications and armament, for it is to be remembered that coast fortifications of today, unlike the permanent works of an earlier time, look only toward the sea, and of themselves are helpless against land attack; hence they must be protected at flank and rear from approach by hostile troops and landing parties.

In these days every serious sea attack, to be successful, must be accompanied by land operations, a fact well illustrated by the fall of Tsingtau and especially by the desperate sea fights of the Dardanelles and of the Gallipoli Peninsula and the subsequent land attacks. It is evident that though ships unsupported may cause great damage and even destroy cities or fortified positions, they can produce but little effect upon the ultimate result of a campaign unless combined with land operations, by means of which the defense is not only destroyed, but overwhelmed, the objective occupied, together with the surrounding regions.

It appears, then, that the country must be prepared to prevent throughout the vast extent of its seaboard the seizure and occupation of any one of many important points, both fortified and unfortified, and of all of its harbors and landing places useful to an enemy. This implies the existence of a mobile force so placed and so large and effective in organization as to insure, on the one hand, the safety of exposed positions by proper dispositions of troops immediately needed; and, on the other, by concentration of the major part of these mobile troops in reserve at strategic positions of the coast or possibly of the other frontiers as to permit the use of an overwhelming number of defense troops at any threatened point.

In the defense by a mobile army the plan adopted may well be somewhat as follows: The Atlantic, the Gulf,

A signal station for visual communication captured from the Germans by American signalmen



Men of the 104th Field Signal Battalion, U. S. Army, communicating by wig-wag and wireless telegraphy at Camp McClellan, Anniston, Alabama

Where a plank must serve to cross the stream over which telegraph lines are thrown

and the Pacific seaboards will be divided into defensive areas, the extent and boundaries of which will depend upon strategic, geographical, and economic conditions. These areas will not, as a rule, be coextensive with military departments, since they depend upon different conditions and lie mainly along the sea. They will be controlled by their own general officers, acting presumably under one chief. In each area there will exist in war a mobile force adequate not only for its defense proper—that is, for land defense of fixed positions, unprotected harbors, and other vulnerable points within the area itself—but for service with other troops mobilized and held as a general reserve. Within defensive areas there will be placed a sufficient number of men of the regular army, of the trained citizenry, and of the organized militia of the state or neighboring states to form a nucleus of the force required. In addition to the aero squadrons, which form part of a division of the mobile army, there should, of course, be gathered together all of the flying men who can be brought into service with the militia or the volunteers, and to them should be allotted the duty of watching the coasts, so far as practicable.

It should be evident that of this force the men most needed in the preliminary work of the defense are not coast artillerymen alone, but engineers, and signal troops, especially of the aviation section, since the first step in mobilization is the establishment of lines of information, of which soldiers alone should be in control, and the training of airmen.

The mobile troops of the coast defense obviously require ample strength in engineer and signal troops, field and horse artillery, and a due proportion of cavalry to erect and defend the field works on the land fronts of fixed positions, to establish and maintain lines of information, to check sudden attempts at coast landing, and to perform the duties of mounted troops in the field and for air service.

It is certain that if so trained the small quotas of state troops, are of the utmost value to the defense at a time when the lines of information—the telegraph, the telephone, radio and air service—are urgently needed in the organization, disposition, and control of newly organized levies. Together with the signalmen of the regular army, they may well undertake the organization of additional signal troops from the citizenry called to the colors.

If it becomes necessary to put forth the strength of the country by calling to the colors the larger part of the mighty reserve available for national defense, it is certain that the total number of men of the ultimate levy will be so enormous that occasion for mobilization of the whole can hardly arise. But though the *leve en masse* may never be resorted to in this country, a force called to the national defense in a great war is no small thing, and the work of turning it into an efficient army and of supplying it with an adequate force of technical troops properly equipped for the field requires the best efforts of every trained man of the service.

General levies are certain at first to be weak in these very arms, since they are of necessity almost nonexistent with the organized militia of many of the states in ordinary times. Lack of the assistance of technical troops hampers the defense, gives to the troops little mobility, and compels them to remain tied to their base or semipermanent camps. This condition will doubtless be corrected as time goes on, but its existence at first multiplies the lines of information and the duties of signal troops. It is certain therefore that the communications by which the first line and the reserves will be linked together and to the permanent works should from the early efforts at concentration be ample and effective, and so continue, for without them the whole army of the defense becomes a mere aggregation of inert units.

Supports

A third class of troops organized are, if not large in number, at least of vital importance in coast defense; they are the support of artillery positions proper. These men, placed at stations suitable to the defense of fixed positions against land attack, act in concert with the coast artillery and are under the immediate command of artillery officers, presumably of posts or districts, since it is evident that they must be kept as directly in touch with the officers fighting the positions as are the marines aboard ship. The supports may well be drawn from the mobile troops proper and be composed of the first and best men called to the general defense; that is, of such troops of the regular army as can be assigned to the duty and of the flower of the organized militia. Made up almost entirely of infantry and field artillery, with as many machine-gun batteries as may be available, there should be added a far larger proportion of signalmen than is usually considered necessary for an army in the field, since upon these men falls the service of information not merely with other elements of artillery defense, but with the fixed positions, the mobile troops, coast guard, and with the navy.

The lines of information of these supporting troops are those of the field army. They will be mainly dependent upon the buzzer, airplane—or perhaps the dirigible—the radio, field telegraph or telephone, and visual signaling.

In considering defense against invasion, it should appear that the mobile troops indicated will stretch over many miles of country and operate under widely varying conditions. Even more than for a well-organized army in campaign, therefore, the lines of information for the, at first, somewhat unorganized forces of the general defense must be ample and widely extended.

Indeed, except in emergencies, these lines are more necessary in the early days of the defense than later when the machine moves smoothly, but at all times the mobile troops, without an adequate service of information, have rather less direction and mobility than a collection of tortoises. Properly laid, the lines of information not only form a network throughout the defense area but tie each theater of operations to the others and provide the entire army with the lines heretofore shown to be essential in the field.

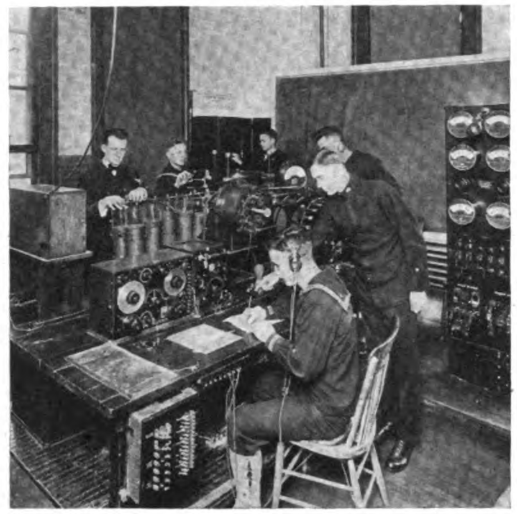
With headquarters of the defense and those of mobile troops fixed at the places best suited tactically for the purpose—and it is reasonably certain that these positions lie at centers of commercial activity—they will be distant from the camps of divisions and brigades and still farther separated from the smaller commands and detachments, from the artillery headquarters and from observation stations and outposts of coast defense. Yet with all these commanding officers of the mobile forces must be kept in constant and immediate touch, as well as with the military commanders of departments, should the latter not be in command of the general defense—and with Washington. In turn, army, division, and brigade headquarters must be kept in communication with dependent and outlying commands; these with the observation stations and coast patrol; and the latter given the power to communicate readily with the floating defenses, with artillery districts, and with ships.

For the mobile coast army the systems of information needed are even more extensive and varied than is considered necessary for a field army in campaign; and it follows that the proportion of signal troops to line soldiers in coast defense should be increased.

It is hopeless to suppose that the Signal Corps of the regular establishment can ever supply more than a leaven for the mass of men needed, especially for the air service, or even that the militia possessing signal troops of ap-

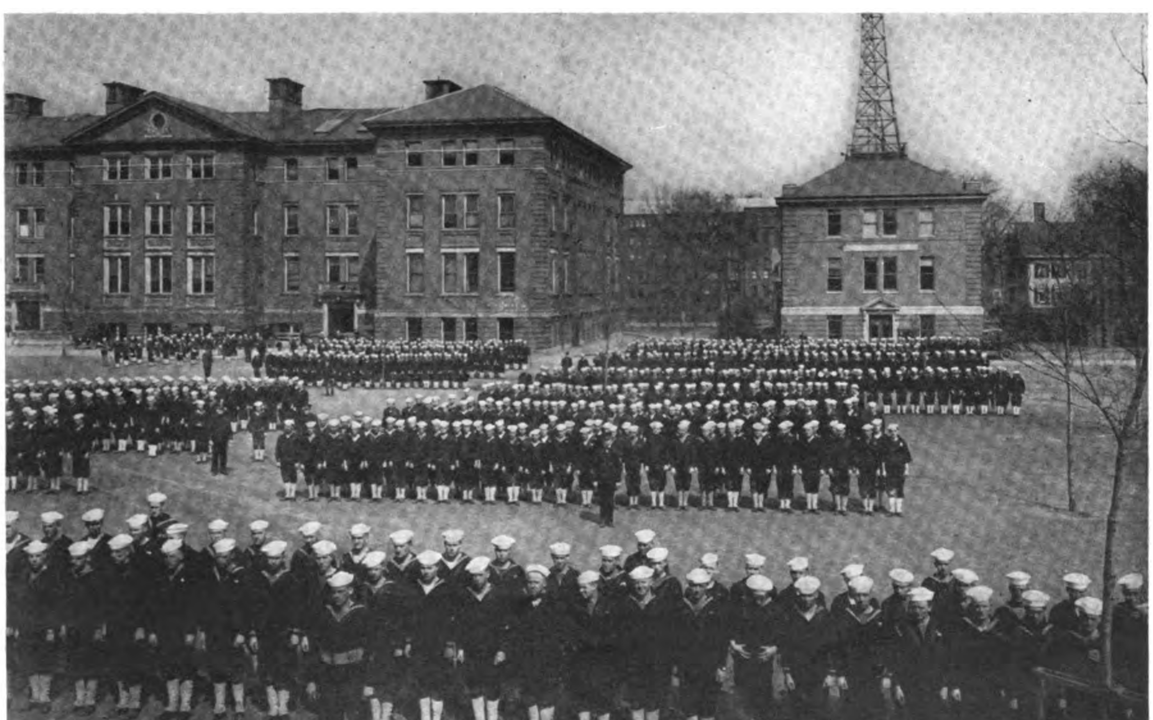
Harvard Radio School

Photos: Edwin Levick



Above: receiving instruction in manipulation of various types of tuners in a room which presents to the student the many parts of assembled wireless sets

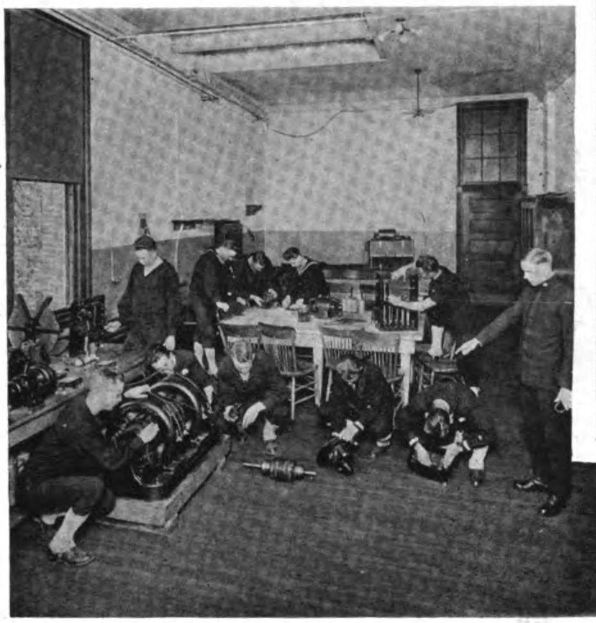
To the left: an outdoor demonstration of portable radio equipment, a suitcase pack set and hand generator in field operation



A stirring sight is the assembly for inspection and review with historical buildings and laboratories forming a background

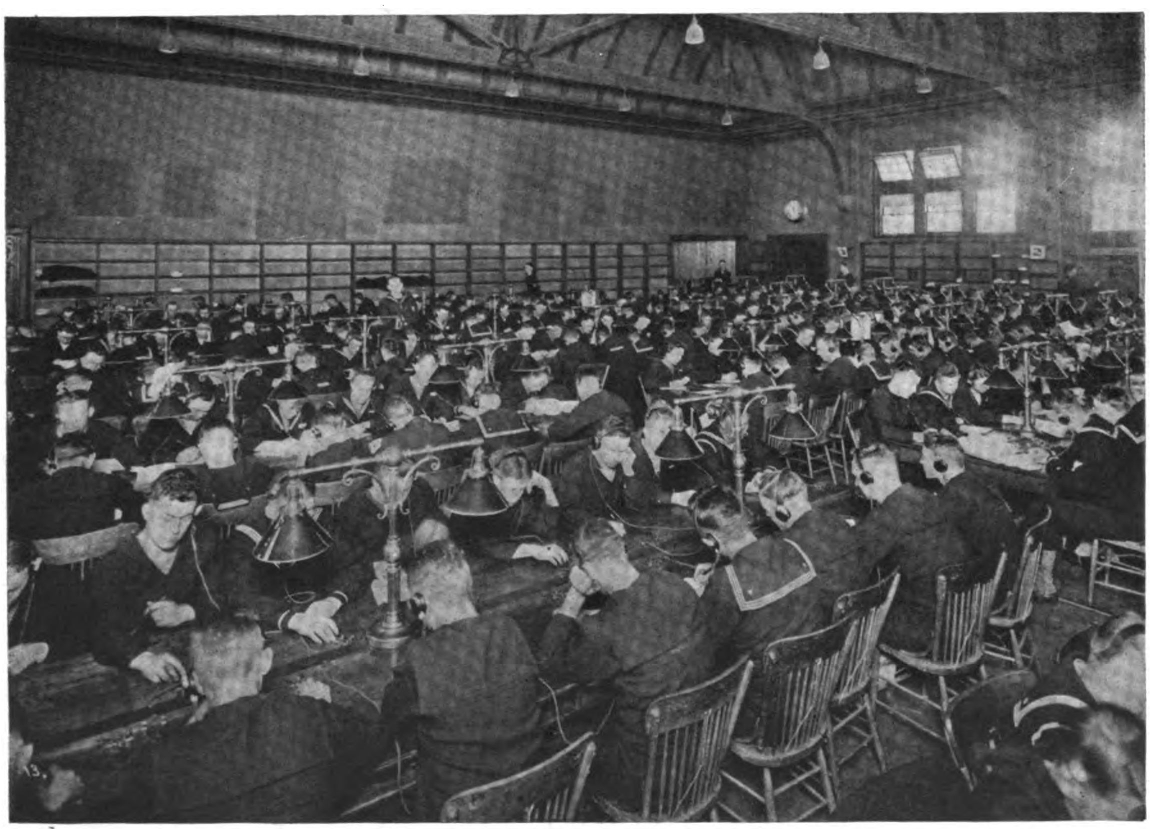
Six Views of Some of the Thousands of Young Men Who are Training at Cambridge, Mass. as Wireless Operators for the U. S. Navy.

(See also page 44)



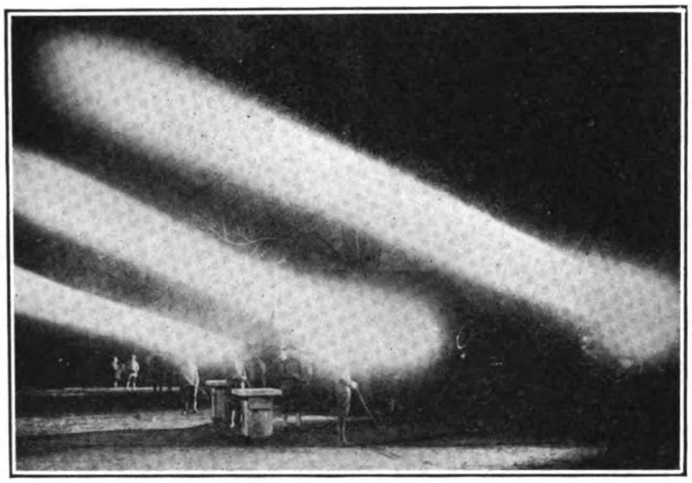
Above: a class of stalwart youths intent on mastery of the circuits of a wireless telegraph set

To the left: the practical application of class-room instruction carried out in the assembling room, where motor generators, gaps and transformers are taken apart and put together



One class of 800 boys learning how to send and receive in the code instruction room

proved efficiency can provide more than the framework of the organizations required. The signal troops mobilized for war must be filled in by men drawn direct from civil life. But excellent and abundant as the material for these troops undoubtedly is among the men engaged in the electrical and mechanical pursuits, and from the few trained in airplane work, such men before they can be of any real value must be made into soldiers. The Signal Corps of the army will never have the numbers or the opportunity to take upon itself alone this training, and the assistance of the organized militia and of suitable and willing men in civil life must be asked and given. The training must be quick and effective, and therefore be performed by men who have themselves been drilled in peace in the methods of the Signal Corps of the army. Unfortunately, trained militiamen and airmen are at present few and are confined to a small number of states, and even where signal organizations exist, they are not always given, be it said without disparagement of the troops themselves, the strength in numbers, the equipment, nor, up to now, the training to make them immediately valuable in coast defense.



Powerful searchlights such as these are now vital to coast defense, the problems of which and their relation to the Signal Corps are discussed in this article

Service of Aircraft in Coast Defense

A third and very important factor in coast defense is the service of air craft, and it is becoming increasingly evident that in addition to lines of information laid or worked on land, there must now be recognized and carefully considered the part played in coast defense and observation by aerial fleets. It is not intended here to speak of the airplane merely, but to suggest also the potential value of the lighter-than-air craft, whose special use is now thought to be in scouting or reconnaissance work, which means, of course, its use as a coast patrol.

Divided into areas or districts patrolled by dirigibles or airplanes, all communicating back to central stations and maneuvering far out to sea, such scouts should make impossible a hidden approach or surprise attack by an enemy. The captive balloon also finds a useful place in service of this kind. But the time has not yet arrived to indicate definitely what form the defense air service will take. It has been suggested that the coasts of the country be divided into sections or areas, each of which should contain an aerodrome or center from which scouting land and sea planes could operate at sea and send reports by radio, if satisfactorily installed, to the central stations regarding the movements of enemies' or friendly ships.

Whether this air patrol shall eventually be installed and conducted by the army, the navy, or the coast guard is undecided, and in the present condition of affairs is not a matter requiring consideration here. There is involved, however, a vast and important field of Signal Corps work, not alone in this aviation service, but in the transmission by wire, radio or otherwise, news received from aircraft at central stations, often located at isolated points to the proper headquarters.

The fourth factor of the coast defense, and that one which depends for its value, if possible, even more closely upon the lines of information than others, is the coast patrol, or coast guard, as it is now called.

To a student of the present condition of our defense it will perhaps appear that the important subject of coast observations, or coast patrol, has not received from the army the attention it deserves. Radio and signal stations have been erected within artillery districts, and by the navy; but great stretches of coast, often containing good harbors, landing beaches and magnificent lookout stations remain without the means of rapidly communicating their news to the telegraph and telephone lines of the country. At many of the lookout stations valuable information of friend or enemy at sea may be gathered, yet they remain in general unprepared for service in war. The need of the co-operation of the trained men and efficient equipment prepared by the Signal Corps for just this kind of work is important.

Without the full co-operation of the Signal Corps of the army and the participation of troops trained in the service of lines of information and in the use of the airplane; the establishment of signal stations, and telegraph, telephone, and buzzer lines; cables; the captive balloon and the dirigible, it is hard to see not merely how the best methods of gathering intelligence in war can be employed by a coast guard, but how, when so gathered, the information obtained can be transmitted to the centers of control, to artillery fixed positions and their auxiliaries, and to the mobile army from distant observation stations, coast islands, and lighthouse, or from the floating auxiliaries and passing ships, with the speed and certainty which alone make such information valuable.

Signal Corps News

Citations for Bravery

The following is a list of officers and men cited by the Commanding General of the French Army in which our First Division is serving, for heroism and gallantry in action displayed during recent operations at Cantigny.

PVT. JOHN J. POOLE, distinguished bravery in repairing telephone lines under heavy shell fire and in maintaining communications.

FIRST LIEUT. VOLNEY B. BOWLES displayed great courage in stringing wire and in maintaining communications under exceptionally heavy shell fire.

PVT. (FIRST CLASS) OSCAR A. BONDLID, great courage and bravery in repairing, under heavy shell fire a telephone cable between the division machine-gun officer and his group commander. Although hit by shell fragments, he continued his work regardless of danger.

CAPT. WILLIAM T. CROOK, displayed courage in maintaining telephone communications and great efficiency in enabling the command to follow, all the time, the progress of the fighting.

PVTS. ROY SAGE AND EARL ARNOLD, worked 12 hours on the night of May 27 laying telephone lines which were cut three times, compelling them to return for more wire under terrific shell fire and gas bombardment.

PVT. CHARLES D. FAIR, was killed while repairing telephone lines under shell fire.

PVTS. JOSEPH BECK, ERNEST U. BECKER, HENRY C. FRANZ, EDGAR A. HARTMEN, ROBERT E. CARSON, MIKE VUJNOVICK, for repairing telephone lines under shell fire; all wounded.

* * *

Staff Duty in Washington

General Orders, No. 53:

III. Induction into military service for duty with the General Staff and bureaus in Washington is authorized only in cases of men technically qualified for such duty, physically disqualified for general military service, and physically qualified for special and limited military service only.

* * *

Service and Wound Chevrons

General Orders, No. 53:

IV. Subparagraphs (c) and (d), paragraph 1, and paragraphs 7 and 8, General Orders, No. 6, War Department, 1918, are amended to read as follows:

1. * * * (c) War-service chevrons.

A gold chevron of standard material and design, to be worn on the lower half of the left sleeve of all uniform coats, except fatigue coats, by each officer, field clerk, and enlisted man who has served six months in a theater of operations during the present war as an officer, field clerk, or enlisted man of the armies of the United States, and an additional gold chevron for each six months of similar service thereafter.

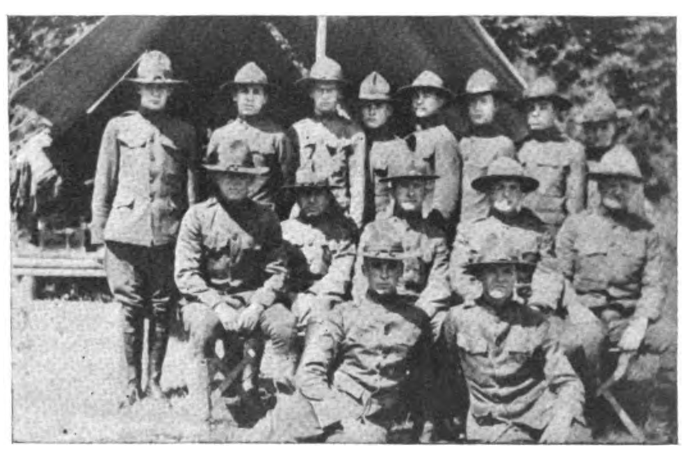
A sky-blue cloth chevron of the same pattern and worn in the same manner as the gold chevron by each officer, field clerk, and enlisted man who has served under the conditions prescribed for the gold chevron, but has left the theater of operations prior to the completion of six months' service therein. Should a person subsequently return to the theater of operations for duty therein, the blue-cloth chevron will be replaced by the gold chevron upon the completion of a total of six months of service in the theater of operations, after which only gold chevrons will be worn to indicate war service. The right to wear war-service chevrons is limited to those officers, field clerks, and enlisted men whose official duty requires their presence in a theater of operations, as distinguished from those who may visit such a theater without having been ordered thereto for duty. The term "theater of operations" is as defined in Field Service Regulations, 1914, as corrected to April 15, 1917.

War-service chevrons of the same material and design and similarly placed will be worn on the coat, overcoat, or waist of their prescribed uniform by all other uniformed personnel of the authorized Military Establishment. They will be worn under the same conditions as prescribed for officers, field clerks and enlisted men.

(d) Wound chevrons.

A gold chevron of pattern identical with that of the war-service chevron, to be worn on the lower half of the right sleeve of all uniform coats, except fatigue coats, by each officer, field clerk, and enlisted man who has received or who may hereafter receive a wound in action with the enemy, or as the result of an act of the enemy, which necessitates treatment by a medical officer, and an additional chevron for each additional wound; but not more than one chevron will be worn for two or more wounds received at the same time. Disablement by gas necessitating treatment by a medical officer shall be considered to be a wound within the meaning of this order.

Wound chevrons of the same material and design and similarly placed will be worn on the coat, overcoat, or waist of their prescribed uniform by all other uniformed personnel of the authorized Military Establishment. They will be worn under the same conditions as prescribed for officers, field clerks, and enlisted men.



A group of officers of American Guard, N. Y. Division, in training camp at Bear Mountain. Left to right seated: Captain C. Jones, West Point; Major C. S. Nyman; Major W. H. Elliott, Adjutant General; Major J. A. White, Chief Signal Officer (Editor, The Wireless Age); Captain W. Farrington, Post Adjutant; Seated, in front: Captain C. P. Young, West Point, and Captain W. R. Brewster, West Point. Standing, left to right: Lieutenants Solomon, Cogan and Schloss; Captains Horn and Bloom; Lieutenants Tropani, Henle and Keeler

Wartime Wireless Instruction

A Practical Course for Radio Operators

By Elmer E. Bucher

Director of Instruction, Marconi Institute

ARTICLE XVIII

Editor's Note—This is the eighteenth installment of a condensed course in wireless telegraphy, especially prepared for training young men and women in the technical phases of radio in the shortest possible time. It is written particularly with the view of instructing prospective radio operators whose spirit of patriotism has inspired a desire to join signal branches of the United States reserve forces or the staff of a commercial wireless telegraph company, but who live at points far from wireless telegraph schools. The lessons to be published serially in this magazine are, in fact, a condensed version of the textbook, "Practical Wireless Telegraphy," and those students who have the opportunity and desire to go more fully into the subject will find the author's textbook a complete exposition of the wireless art in its most up-to-date phases. Where time will permit, its use in conjunction with this course is recommended.

The outstanding feature of the lessons will be the absence of cumbersome detail. Being intended to assist men to qualify for commercial positions in the shortest possible time consistent with a perfect understanding of the duties of operators, the course will contain only the essentials required to obtain a Government commercial first grade license certificate and knowledge of the practical operation of wireless telegraph apparatus.

To aid in an easy grasp of the lessons as they appear, numerous diagrams and drawings will illustrate the text, and, in so far as possible, the material pertaining to a particular diagram or illustration will be placed on the same page.

Because they will only contain the essential instructions for working modern wireless telegraph equipment, the lessons will be presented in such a way that the field telegraphist can use them in action as well as the student at home.

Beginning with the elements of electricity and magnetism, the course will continue through the construction and functioning of dynamos and motors, high voltage transformers into wireless telegraph equipment proper. Complete instruction will be given in the tuning of radio sets, adjustments of transmitting and receiving apparatus and elementary practical measurements.

This series began in the May, 1917, issue of The Wireless Age. Beginners should secure back copies, as the subject matter presented therein will aid them to grasp the explanations more readily. If possible, the series should be followed consecutively.

THE VACUUM TUBE OSCILLATION DETECTOR

(1) A heated metal in a vacuum gives rise to the emission of small particles of electricity called **electrons.**

(2) These particles of electricity are **negatively charged** and may be influenced by an electrostatic or an electromagnetic field.

(3) About 1800 electrons constitute an **atom,** which is the smallest particle of matter that can take part in chemical action.

(4) The **normal atom** is assumed to consist of a definite number of **electrons** grouped about a nucleus having **a positive charge** and so long as none of the component electrons are driven from the atom, it possesses no detectable electrical charge.

(5) If electrons are driven from a normal atom, **ionization** is said to take place and the atom then possesses a **deficiency of negative electricity.** It therefore takes on the characteristics of a positively charged body and is then called **a positive ion.**

(6) If electrons are added to a normal atom, the latter possesses an excess of negative electricity and it takes on the properties of a negatively charged body.

(7) It is believed that the **flow of current** in a conductor is the **movement of a great number of electrons.**

(8) Electrons driven from an atom by raising, for example, the temperature of metal to incandescence, may act as carriers of electricity between two metallic elements in vacuua.

THE OSCILLATION VALVE

(1) The electronic emission of an incandescent lamp filament can be put to a useful purpose in connection with the reception of radio telegraphic signals. They were first employed in this way by Dr. J. A. Fleming.

(2) Fleming's original oscillation valve comprised a **lamp filament** and a **metallic plate** sealed in an exhausted tube. He found that when the filament was brought to incandescence, **electricity could readily flow from the plate to the filament but it was opposed in the opposite direction**; that is, the tube proved to be an efficient **rectifier** and it performed this function at frequencies up to several million cycles per second.

(3) It should be kept in mind here that in accordance with the electron theory, electrons flow oppositely through a circuit to the formerly accepted assumption as to the flow of current. For example in terms of the electron theory, negative electricity flows from the filament to the plate in the vacuum tube; but in accordance with the old theory, electricity can pass from the plate to the filament but not in the other direction.

(4) To secure the valve effect connection must be made to the **negative side** of the lamp filament and to the plate.

(5) The Fleming valve may be used as a simple **rectifier** for the **detection** of **radio frequency currents** or advantage may be taken of its **non-uniform conductivity** as with the carborundum rectifier. In the latter case, the E.M.F. of a local battery is applied to the space between the plate and filament.

(6) By placing a metallic element called a **grid** between the plate and filament, a wider range of circuits may be employed adapting the tube to a great variety of uses. A tube so constructed is called a "three-electrode" valve.

(7) Such tubes may be connected for **cascade or regenerative amplification.**

CASCADE AMPLIFIERS

(1) The vacuum tube acts as a **repeater of alternating currents** and it will perform that function at frequencies up to several million cycles per second. That is, if an alternating current be impressed upon the grid and film of the three electrode tube, the plate current (supplied by a local battery) will rise and fall at the frequency of the impressed E.M.F. In a properly constructed tube, the current will be repeated with **amplification.**

(2) The **output current** of the tube may in turn be impressed upon the grid and filament of a second tube for further amplification. This process may be continued through several steps. This is called **cascade amplification.**

(3) If radio frequency currents are to be amplified progressively through several steps, **air core radio frequency transformers** are connected between the **output circuit** of one tube and the **input circuit** of the next tube. For the amplification of audio frequency currents **iron core transformers** are connected between successive steps.

(4) If the plate circuit of the tube is coupled inductively, conductively or electrostatically to the grid circuit, **regenerative amplification** results; that is, part of the energy released in the plate circuit is **fed back** to the grid circuit to amplify incoming radio signals. Circuits of this type were first disclosed by Capt. Armstrong. They are termed **regenerative circuits** and may be used for the **self-amplification** of audio or radio frequency currents. Such circuits are often termed **"feed back"** circuits.

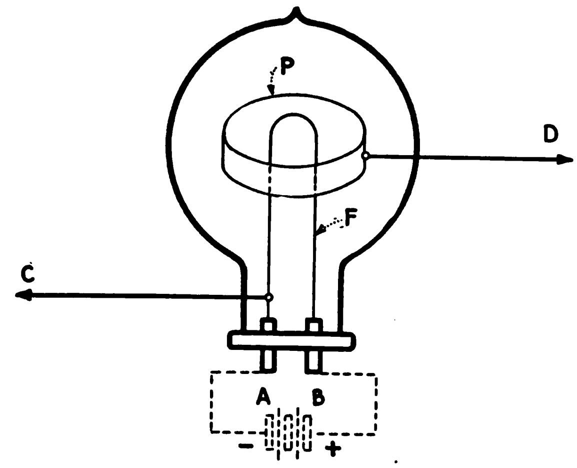


Figure 167—Simplified sketch of Fleming's oscillation valve. A lamp filament F and a metallic plate P are sealed in a highly exhausted tube. The filament is brought to incandescence by a 4 to 12 volt battery. To secure the valve effect, connection is made to the terminals C, D. The tube acts as a rectifier of alternating currents at frequencies up to millions of cycles per second

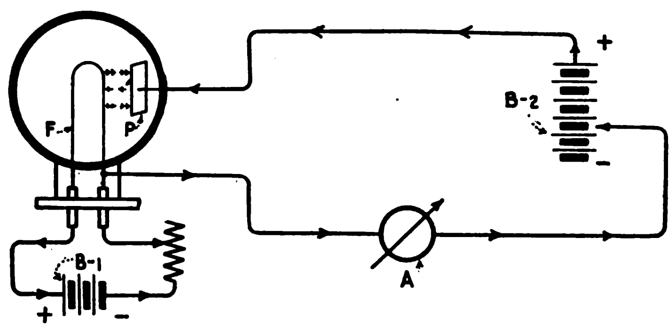


Figure 168

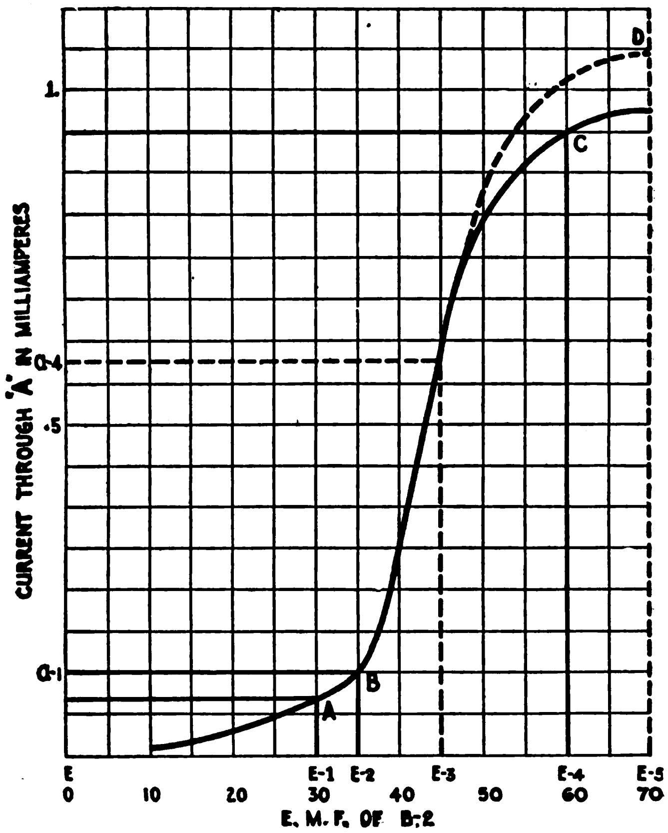


Figure 169—Characteristic curve of the two-electrode tube. This curve shows the relation between the plate current and the E.M.F. of the battery B-2. The curve indicates that the conductivity of the valve is not a constant, but that it varies with the current flowing. At point B a slight increase in the local E.M.F. causes a very great increase of the plate current, but at point C the current begins to fall off. This is called the point of saturation. As an oscillation detector the valve is generally more sensitive, that is, it will give greater response in a telephone, from a radio frequency signal when the local potential is adjusted to correspond to points B or C. What amounts to a rectified current will then pass through the receiving telephone. With some valves other points on the characteristic curve give good response in the telephone

OBJECT OF THE DIAGRAM

To indicate the connections of the apparatus for demonstrating the rectifying properties of the Fleming valve.

PRINCIPLE

An electrical current can pass from the plate to the filament in the vacuum valve, but it is opposed in the opposite direction.

DESCRIPTION OF THE DRAWING

The negative side of the filament F and the plate P are connected to the negative and positive poles of a high voltage battery B-2 respectively. Filament F is rendered incandescent by a battery B-1. A milliammeter is connected in series with B-2.

OPERATION

When plate P is connected to the positive pole of B-2, the meter A will indicate the passage of current through the valve (from P to F), but if the negative pole of B-2 is connected to the plate the meter will not register.

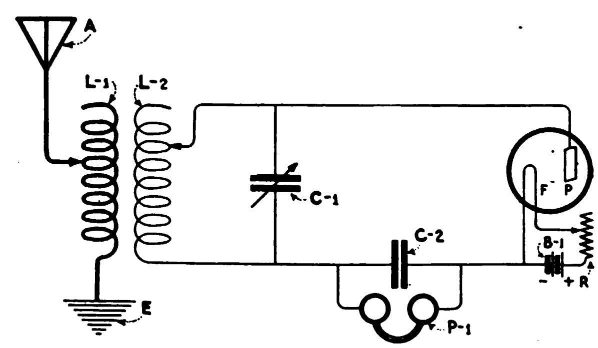


Figure 170

OBJECT OF THE DIAGRAM

To show the use of the two-electrode Fleming valve as a simple rectifier.

DESCRIPTION OF THE DRAWING

The primary coil of a receiving transformer is indicated at L-1 and the secondary coil at L-2. The usual secondary condenser is shown at C-1, the telephone condenser at C-2, and the telephones at P-1. The valve contains the filament F and the plate P. Filament F is fed by the battery B-1 and the incandescence of the filament is regulated on the rheostat R.

OPERATION

When the receiving transformer is tuned to a distant transmitter, an E.M.F. at a radio frequency is impressed between the plate P and the filament F. When P is charged to a

positive potential, electricity can pass from P to F, but when P is charged to a negative potential, no electrons are drawn over to the plate, and consequently no current passes the valve. The telephone condenser C-2, therefore receives a uni-directional charge over the duration of a wave train, and at the termination thereof discharges through telephone P-1. Groups of radio frequency currents are thus converted to uni-directional pulses which actuate the telephone diaphragm.

SPECIAL REMARKS

To obtain the correct operating adjustment of the tube, the operator regulates the incandescence of the filament F by means of the rheostat R until the loudest signals are obtained.

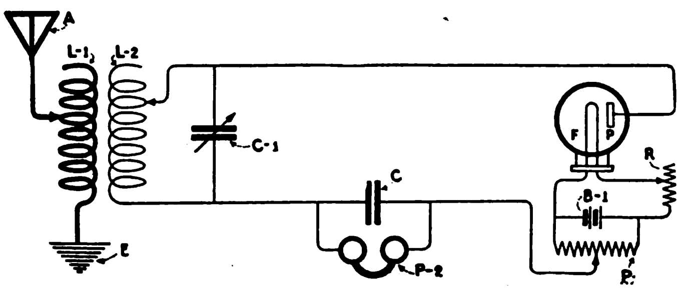


Figure 171

OBJECT OF THE DIAGRAM

To disclose the circuits for the Fleming oscillation valve, in which advantage is taken of the non-uniform conductivity of the tube.

DESCRIPTION OF THE DRAWING

The radio frequency elements of the receiving tuner are indicated by the usual notations. Battery B-1 is shunted by a potentiometer P-1 through which the plate P may be charged to a positive potential. If the sliding contact on P-1 is moved to the right, P is charged positively, but if moved to the extreme left the potential of P in respect to F is reduced to zero. That is, in the former case current flows from the positive pole of the battery B-1 through P-2 through L-2, from the plate P to the filament F, back to the negative pole of the battery.

OPERATION

The best operating adjustment is secured by sliding the variable contact along P-1 until the loudest signals are heard in the telephone.

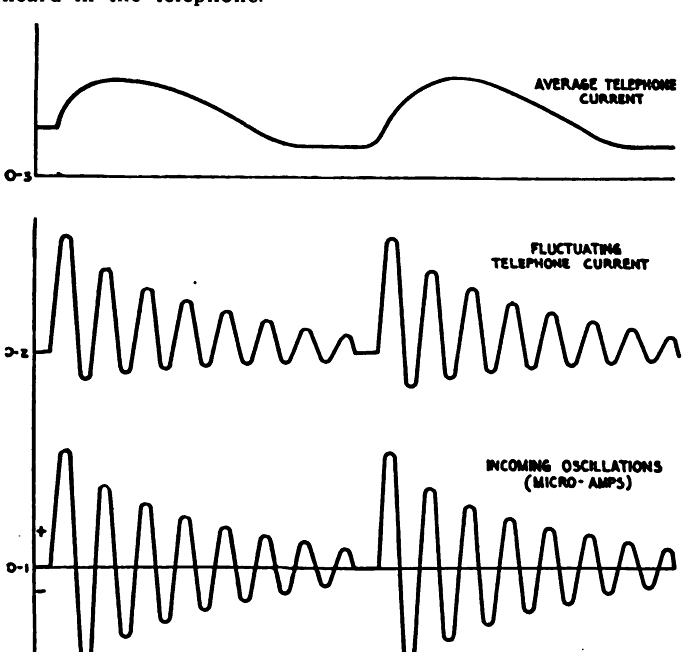


Figure 172—Showing the phenomena involved in the detection of radio frequency oscillations by the two-electrode vacuum tube connected as in figure 171. Graph 0-1 indicates the incoming radio frequency oscillations; graph 0-2, the fluctuating telephone current, and graph 0-3, the average effect of the current supplied to the telephone. This is the effect obtained on the lower bend of the characteristic curve shown in figure 169. At the upper bend of the curve the incoming signals will cause a large decrease in the telephone current. The effect on the telephone in either case is the same.

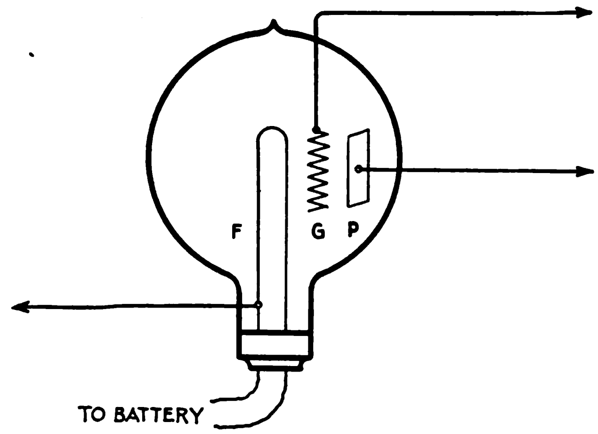


Figure 173—Simplified sketch of the three-electrode vacuum tube, often called the electron relay. The glass envelop contains the filament F, the grid element G, and the plate P. In certain types of tubes, the filament, plate and grid are made of tungsten. Other metals, however, are often employed. One popular type of tube contains a platinum filament, a tungsten grid and a nickel plate.

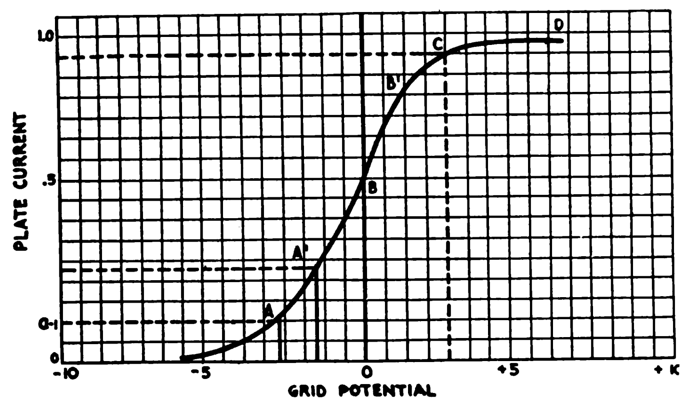


Figure 174—Showing one characteristic curve of the three-electrode vacuum tube. The horizontal axis indicates the potential of the grid in respect to the filament, and the vertical axis the current flowing through the plate circuit. This particular curve indicates that when the potential from grid to the filament is approximately zero, the plate current is 0.5 milliampere. On the other hand, with the grid potential at 5 volts negative, the current in the plate circuit is practically zero. The point of saturation occurs in the region of C; in other words, the maximum plate current flows when the potential of the grid in respect to the filament is about 3½ volts positive.

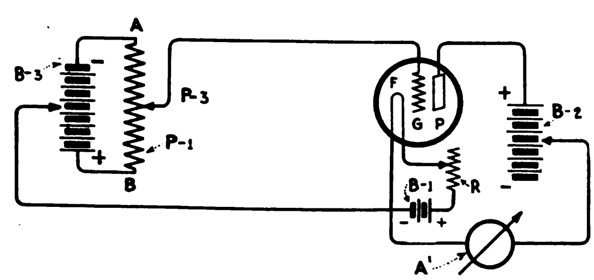


Figure 175—Connections of the apparatus for obtaining the grid-potential, plate-current characteristic of the three-electrode tube. A variable E.M.F. supplied by the battery B-3 is impressed upon the grid G, and the filament F. A battery B-2 supplies current for the plate circuit, the path of the plate current being from the positive side of B-2, from the plate P to the filament F, back to the negative terminal of B-2. A low-range milliammeter A′ is connected in series with the plate circuit. By sliding the contact of the potentiometer P-3 towards A, the grid G will be charged negatively in respect to the filament; but by moving the contact in the opposite direction, the grid G will be charged positively. The strength of the plate current under different values of E.M.F. applied to the grid circuit, is shown in figure 174.

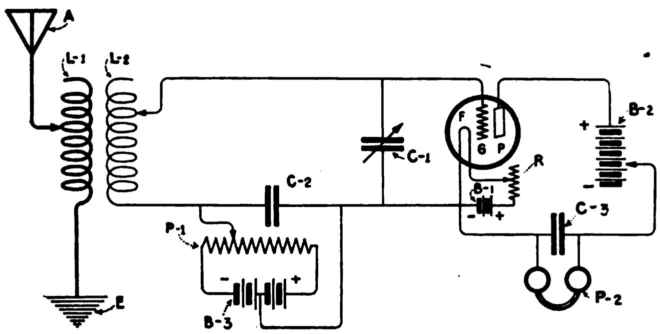


Figure 176

OBJECT OF THE DIAGRAM

To show the fundamental construction and one circuit for use of the three-electrode vacuum tube as an oscillation detector in radio telegraphy.

PRINCIPLE

A metallic element called a grid inserted between the filament and the plate of the vacuum tube may be employed to control the strength of the plate current.

If the grid is charged positively by an external E.M.F., the plate current is increased, but if charged negatively, the plate current is decreased.

Any variable E.M.F. impressed upon the grid circuit will be repeated in the plate circuit with amplification.

DESCRIPTION OF THE DRAWING

The tube contains the filament F, the grid G, and the plate P. The plate current is supplied by the battery B-2 and the filament current by the battery B-1.

The grid G and the negative side of the filament F are connected to the secondary terminals of the receiving transformer.

In order to control definitely the voltage of the grid G in respect to the filament F, a grid battery B-2 shunted by potentiometer P-1 is included in the grid circuit.

OPERATION

To obtain the best adjustment of the vacuum tube the operator regulates the incandescence of the filament by the rheostat R and adjusts the voltage of the battery B-2 until, for example, the loudest signals are obtained in the telephone P-2 from a test buzzer in inductive relation to some part of the receiver circuit.

During the reception of the signals, the sliding contact on the potentiometer P-1 is moved back and forth until the loudest signals are obtained. In some tube receiver sets the incandescence of the filament is regulated by an ammeter connected in series, but if the ammeter is not supplied the correct adjustment is obtained by test.

SPECIAL REMARKS

(1) When the operator adjusts the circuit of figure 176 for the maximum strength of signals, he works the tube at either point A or point B on the characteristic curve of figure 174.

(2) When the receiving transformer is tuned to the distant transmitter, an alternating E.M.F. is impressed between the grid G and the filament F. If the potential of the grid in respect to the filament F is adjusted by the battery B-3 to point A on the characteristic curve, the negative half of the incoming cycle will reduce the plate current and the positive half will increase it. But as the curve indicates the increase will exceed the decrease and therefore what amounts to a rectified current will flow in the plate circuit which charges the condenser C-3. Condenser C-3 then probably discharges in one direction through the head telephone P-2.

(3) It is clear from the curve that if the potential of the grid in respect to the filament is regulated to point C, then the negative half of the incoming oscillation will cause a large decrease in the plate current and the positive half a slight increase. In either way the telephone diaphragm will be impulsed once for each group of incoming oscillations.

(4) It is clear from the curve of figure 174 that if the potential of the grid in respect to the filament lies along the region from A-1 to B-1 and a radio frequency current is impressed upon the grid circuit, it will be repeated in the plate circuit substantially without distortion; that is to say the increases and the decreases of the plate current will be equal. But at other points along the curve, the plate current will either increase to a greater extent than it decreases, or vice versa, with the result that the telephone P-2 is traversed by uni-directional currents.

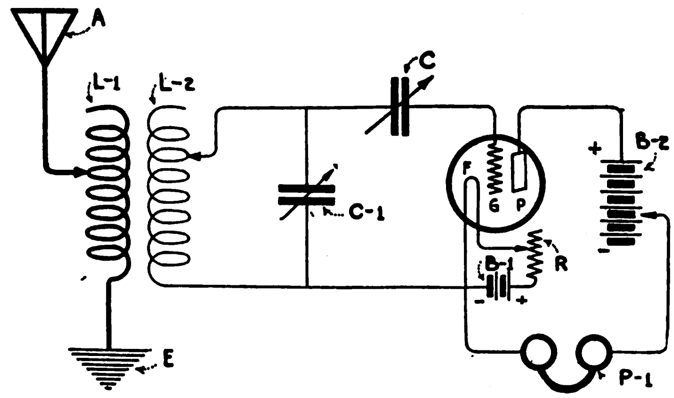


Figure 177

OBJECT OF THE DIAGRAM

To show the circuits of a three-electrode vacuum tube as an oscillation detector, employing a grid condenser.

PRINCIPLE

By connecting a condenser in series with the grid, incoming radio frequency oscillations are rectified and a charge accumulates in the condenser which leaks out at the termination of each wave train. The alternate increase and decrease of the grid potential by this action causes the plate current to vary at the spark frequency of the transmitter.

DESCRIPTION OF THE DRAWING

The receiving transformer is indicated by the usual radio frequency tuning elements, and there is included in series with the grid, a grid condenser C. As usual current from B-2 flows from the plate P to the filament F through the head telephone F-1 to the negative side of the battery.

OPERATION

When the receiving transformer is tuned to the distant transmitter, alternating currents are impressed between the grid G and the filament F. By the usual valve action these currents are rectified between G and F and a uni-directional charge is stored up in the condenser C which is negative on the grid side. As is clear from the characteristic curve, this reduces the plate current, but at the termination of a group of incoming oscillations, the charge leaks out the condenser C through the valve, or through a special leak resistance. The plate current then returns to normal value. This reduction and subsequent increase of the current follows the spark of the transmitter.

As in the circuit of figure 176, the radio frequency currents flowing in the grid circuit are repeated in the plate circuit, but these currents are not heard in the head telephone. They are put to account, however, in the regenerative circuits to be described further on.

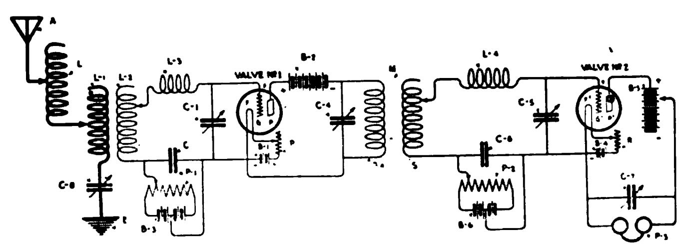


Figure 178

OBJECT OF THE DIAGRAM

To show the connections of vacuum tubes for cascade amplification at radio frequencies.

DESCRIPTION OF THE DRAWING

The plate circuit of valve No. 1 and the grid circuit of valve No. 2 are coupled through a radio frequency transformer M having the primary windings P-4 and the secondary windings S. The grid circuit of valve No. 1 includes the grid battery B-1 and the potentiometer P-1; similarly the grid circuit of valve No. 2 has a grid battery B-6 and a potentiometer P-2.

The antenna, grid and plate circuits of the first valve and the grid circuit of the second valve are tuned to the frequency of the incoming signals.

OPERATION

Assuming the voltages of batteries B-2 and B-5 to be properly adjusted, and the filament temperature of F and F-1 to be regulated by their rheostats, the operator adjusts the potential of the grid to filament of the first valve by means of potentiometer P-1 so that the incoming radio frequency currents are repeated in the plate circuit P-4, C-4 with amplification. The radio frequency current repeated into the plate circuit is impressed upon the grid circuit of the second valve through transformer M, the grid circuit being tuned to the frequency of the signal by the secondary inductances S, the loading inductance L-4, the variable condenser C-5 and the fixed condenser C-6.

The potential of the grid in respect to the filament of the second valve is adjusted by potentiometer P-2 so that the radio frequency current impressed upon the grid circuit is repeated in the plate circuit with distortion; that is, the grid potential is adjusted so that the repeated plate current in the second valve increases to a greater extent than it decreases or vice versa. Then what amounts to a rectified current flows through the head telephone P-5.

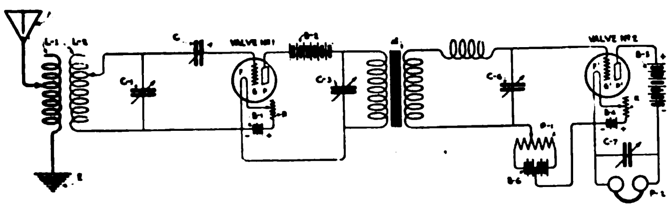


Figure 179

OBJECT OF THE DIAGRAM

To show the circuits of a cascade audio frequency amplifier.

DESCRIPTION OF THE DRAWING

The plate circuit and the grid circuit of the tubes are coupled through an iron core transformer M. A grid condenser C is inserted in the circuit of the first valve to secure an audio frequency relaying effect upon the plate current. The audio frequency current in the plate circuit is impressed upon the grid circuit of a second valve through the iron core transformer M. This circuit includes the battery B-6 and potentiometer P-1 through which the operator adjusts the potential of the grid in respect to the filament to secure the maximum strength of signals in the head telephone.

OPERATION

The capacity of condenser C, the temperature of the filament and the voltage of battery B-2 are adjusted until the maximum possible variation of current is obtained in the plate circuit of B-2 as may be determined by connecting a head telephone in that circuit. The primary and secondary windings of the transformer M are closely coupled. These circuits may be tuned to the desired audio frequency by shunting the primary coil with the condenser C-3 and the secondary coil with condenser C-6. By careful adjustment of the potentiometer P-1 and by variation of the capacity of the condenser C-7 the maximum strength of signals will be obtained.

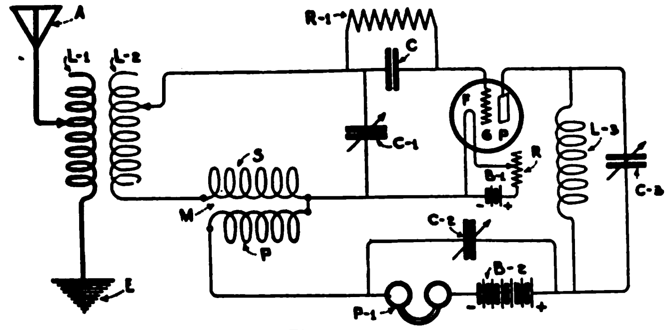


Figure 180

OBJECT OF THE DIAGRAM

To show the complete circuits of Armstrong's regenerative receiver for the amplification of audio or radio frequency currents.

PRINCIPLE

By coupling the plate circuit of a vacuum tube to the grid circuit, either through an iron core or an air core radio frequency transformer, part of the energy liberated in the plate circuit can be fed back to the grid circuit for increased amplification.

DESCRIPTION OF THE DRAWING

The primary winding of the receiving transformer is indicated by L-1, the secondary by L-2 and the plate and grid circuits are coupled through the transformer P, S. The usual shunt secondary condenser is indicated at C-1 and a grid condenser at C. In the case of highly exhausted vacuum tubes condenser C is shunted by a leak resistance of several hundred thousand ohms.

The plate circuit is tuned by the inductance L-3 and the shunt condenser C-3. In order to by-pass the radio frequency current around the head telephone P-1 a condenser C-2 is shunted across the battery and the telephone.

OPERATION

The receiving transformer is tuned to the distant transmitter in the usual way. The correct operating adjustment of the vacuum tube having been obtained, and resonance having been established with the transmitter, the coupling between the coils P and S is carefully varied until the maximum strength of signals is secured.

This coupling must be carefully regulated so as to amplify the incoming signals only, for otherwise the complete circuits of the tube will be set into oscillation at a radio frequency and it will then become a beat receiver.

SPECIAL REMARKS

(1) The production of beat currents is evidenced by the fact that the normal spark note of the spark transmitter is lowered in pitch, but by careful adjustment of the coupling between P and S these signals can be amplified without the production of beats.

(2) If the audio frequency current in the plate circuit is to be amplified, the windings P and S may have an iron core. The inductance of P and S may then amount to several henries each.

The Future Wartime Wireless Series

Part II of this Wartime Wireless Instruction will begin in the November issue. It will deal with undamped wave transmitters and vacuum tube receivers for the reception of continuous oscillations. The direction finder and other special appliances will be treated fundamentally. A discussion of the basic principles of wireless telephony will terminate the series.

Where There's A Will

How Men Were Prepared for Wireless Duties to Meet the Nation's Emergency—Some High Lights on the Cincinnati Effort

By Maurice Henle

"SMILING BILL" Frankenstein is somewhere on the ocean, headed eastward. On his collar is the insignia of the Signal Corps, and in his fertile brain a wealth of dots and dashes which will be turned to Uncle Sam's advantage against the Hun on France's soil.

"Smiling Bill" couldn't and wouldn't stay out of the service. Nature, however, had gambled heavily with his chances, and apparently was winning. At any rate she was smiling broadly. "Bill" was way underweight.

He had his eye on the navy, and some months ago steered for the recruiting station. No luck. He interviewed the army physical examiners, with an equal amount of misfortune. He grew very depressed.

As luck would have it, he happened one day to meet H. Serkowich, an instructor at the Cincinnati Continuation School of Radio Telegraphy, and also connected with the Cincinnati Chamber of Commerce; he told the instructor of his unsuccessful attempts at getting into the service.

"Come to the Radio School, and fit yourself for the radio service," Serkowich advised, "it will fit you for a place in the Signal Corps."

"But I'd have to pass a physical examination to get into the army, and they have turned me down once," Frankenstein said.

"Never mind that," Serkowich reassured him, "you leave getting into the service to me."

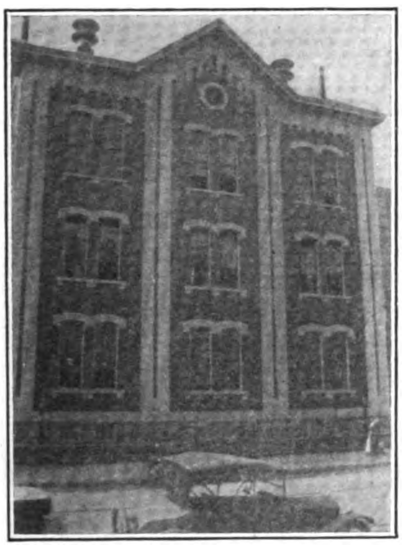
So Bill enrolled at the radio school, which is operated under the auspices of the United States Government and the Cincinnati Board of Education, preparatory to taking his place in the ranks of the Signal Corps. Everything went smoothly; he sailed through the course like a clipper ship through water.

Soon the day came when he was to apply with his certificate of proficiency at the army recruiting office. He approached Serkowich.

"Well," he said, "tomorrow I try to get into the army. I am still thirteen pounds under weight."

"Follow my instructions and before tomorrow night you will be in the army," Serkowich told him.

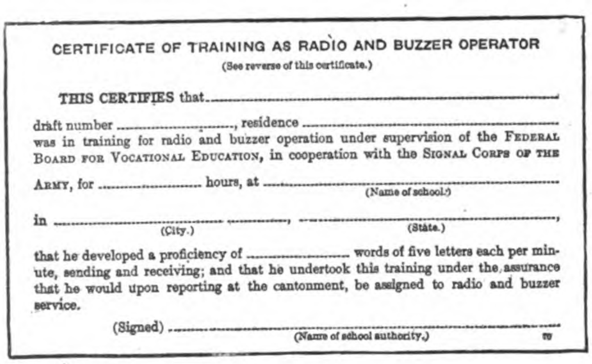
"Bill" gulped when he heard the instructions.



Left—Cincinnati Continuation School, where radio classes are held

Right—Charles H. Elston, assistant prosecutor, Hamilton County, who heard the call of radio and is now an army aviator

Below—Certificate of training issued to men called in the draft



CERTIFICATE OF TRAINING AS RADIO AND BUZZER OPERATOR

(See reverse of this certificate.)

THIS CERTIFIES that..

draft number ...., residence .... was in training for radio and buzzer operation under supervision of the FEDERAL BOARD FOR VOCATIONAL EDUCATION, in cooperation with the SIGNAL CORPS OF THE ARMY, for .... hours, at .... (Name of school.)

in .... (City.) ...., ... (State.)

that he developed a proficiency of .... words of five letters each per minute, sending and receiving; and that he undertook this training under the assurance that he would upon reporting at the cantonment, be assigned to radio and buzzer service.

(Signed) .... (Name of school authority.)

"Buy a dozen large bananas," Serkowich said evenly, "eat them slowly, and between each, drink a full cup of water. You can do it."

A few days later "Bill" again sought Serkowich.

"Well," he said, smiling, "I leave tonight for a port of embarkation. I had hardly arrived at camp when they asked for volunteers for immediate service overseas. I'm happy—but say, listen—I will never again be able to look a banana in the eye!"

Just before sailing, and after a few weeks in an eastern camp, "Bill" wrote back to Serkowich, telling him that he was now legitimately up to the required weight, thanks to the outdoor life.

Shortly after April 6, 1917, when President Wilson spoke the words which were to start the mobilization of a mighty nation's resources, men, money and ships were seen to be the great needs. Millions of each had to be obtained.

The war was 4,000 miles away and miles of water separated Verdun from New York. We had to have ships to take the men and food to France. The cry for ships grew. "We must have ships, ships, and yet more ships!" and the Emergency Fleet Corporation sprang into existence. Men were needed to man the vessels. Wireless operators were needed aboard. "Give us ten thousand radio operators; for the navy, for the land army, and for aviation!"

And it was to help supply this need that the Cincinnati Continuation School for Radio Operators began.

The Federal Board for Vocational Education broadcasted a general appeal to all school boards, asking their co-operation in supplying operators, requesting that the facilities of the school buildings be placed as much as possible at the disposal of the Government.

Cincinnati had the advantage of other cities, in that a somewhat similar work had already been started at the Continuation School, operated by the Cincinnati Board of Education. Telegraph messengers, below the age limit required by law, had to come to the school part of the working day. A course in Morse telegraphy was offered, along with other studies, so that the boys received a fairly practical education.

It was comparatively easy for Superintendent of Schools Randall J. Condon, a famed educator, to broaden the scope of the school.

Miss Mary Conway, the principal of the Continuation School, was a woman with wide experience. With years of practical training behind her, Miss Conway plunged into the new work with vim and vigor. She recognized that without practical surroundings for the students, progress would be necessarily slow. So she acquired a full set of equipment, including typewriters, keys and instruments and transformed the room into a real "Western Union" school.

Progress was rapid and many a young man and woman, as well as older men, obtained a position at the key with the great commercial telegraph companies.

It was at this time that the Ohio National Guard was encamped at Sharonville, Ohio, preparatory to going to Camp Sheridan, Ala. The Signal Corps of the army was in its youth; but the experience of our allies taught us many things which we were not required to have rammed down our throats, and the War Department soon started out in an efficient way to bring the Signal Corps up to a high standard. Major Dube of the Ohio militia, who seemed to have a greater pre-vision than a good many, heard of the good work accomplished at the Continuation School and of the wonderful benefits the telegraph companies were reaping, and brought sixteen of his non-commissioned officers to the school to learn the code.

They were only there a few days when it was seen that there was not a competent instructor to teach the men what they really should have learned—the Continental Code for radio work. Major Dube cast about for a man. He finally decided upon H. Serkowich, with the Cincinnati Chamber of Commerce, a man with wide experience both as a radio and telegraph operator and a wire chief on steamships and railroads.

Serkowich, however, couldn't leave his work at the Chamber of Commerce, nor could he sacrifice the indirect work he was then doing for the Government. He agreed, however, to give his services if the classes would be conducted at night. Miss Conway and Superintendent Condon consented to the change gladly, and the twilight school was started.

Serkowich immediately shifted to the Continental Code and it was not very long before those sixteen "non-coms" and sixteen more had qualified with flying colors, competent to take over the army signalman's job.

Above—Learning radio telegraphy for Uncle Sam in his school for wireless operators in Cincinnati

Left Oval—William Frankenstein, a pupil who met the weight requirements of the army by eating a dozen bananas and drinking as many cups of water, incidentally acquiring proficiency in key manipulation

Right Oval—Julian W. Bronson, a former pupil who has been made an instructor at the Great Lakes Radio School, in charge of hundreds of beginners

In seeking another competent instructor, the Board of Education plucked Frederick W. Dearness, principal of the 12th District School, who was well versed in wireless telegraphy.

Serkowich recently has been commissioned a lieutenant in the navy. He was assigned to the Cincinnati district and is still at the school.

Equipment had been supplied by public-spirited men and women. This equipment, moreover, was complete. The desks, designed by Serkowich to accommodate the maximum number, were installed by the school board carpenters. Buzzer systems and head pieces were given

by the telephone company and a local electric company. In the Morse Section, the typewriters were bought by the Board of Education, as was the other equipment.

About this time the draft became active. The National Army, in its process of formation, needed signal men badly. This dearth of men prompted Colonel L. D. Wildman, U. S. A., of the Signal Corps, stationed at Chicago, to write to the Cincinnati school authorities, appealing to them to help the Government in this crisis.

"In the organization of signal troops," he wrote, "a grave difficulty has been discovered in securing the required number of Morse and radio telegraphers for the first increment of troops. Since it has been found difficult to secure the required telegraphers for the first increment, it is an assured fact that unless immediate steps be taken to increase the number of available telegraphers the situation will be even more serious for further increases of the army. It is, therefore, most important that efforts be devoted to educating students in sending and receiving by the Morse and Continental codes with proficiency."

Wide publicity brought many students, most of whom were of the draft age. One room broadened to two, and two to five.

* * * *

One hundred and fifteen men have received certificates of efficiency from the school and have been recommended to the Federal Board for Vocational Education, at Washington, with which the school is affiliated.

Of the one hundred and fifteen, sixty-two are in the navy, twenty-six in the air service, or Aviation Section, Signal Corps, and twenty-seven in the land army. Many joined the service without receiving their certificates and made good. Enrolments have totaled hundreds. Of the navy's sixty-two, many have gone through Harvard University, and are at this moment on the ocean.

Memorizing the Continental Code is the first step at the school. Recruits are taught to make signals on the telegraph key and to transmit sentences. Practice in code sending and receiving comes next. Then they learn to speed up and to combine speed with accuracy. At each step they are moved up in the school. When they are in the fifth "stage," recruiting officers from the army, navy, and air service give them talks, each pointing out the merits of his particular service.

* * * *

The call of wireless penetrated deep. It spread its enticing fingers into all walks of life. Charles H. Elston, assistant Hamilton county prosecutor, was one of those who heard it and answered in the affirmative.

He is now at the Ohio State University at Columbus putting the finishing touches to his course, from which he will soon emerge a pilot in army aviation.

Elston didn't have to go; he had been placed in Class 3 of the draft. However, he went to the radio school, and was recommended for the Signal Corps. According to letters received by his mother, he attributes the major portion of his rapid progress through the training school to the course at the Cincinnati school.

Julian W. Bronson is another who made good. Because of the training he had received at the Cincinnati school, Bronson was made an instructor at the Great Lakes Radio School and placed in charge of hundreds of beginners. He received his certificate of efficiency November 15, 1917, together with Willard B. George, Matthew Schenchoff and Edward J. Corcoran, the first of the civilians to complete the course.

All four served as instructors for some time; then Bronson, with two others, grew restive for active service, and insisted they be sent to Harvard so as to qualify for service by summer. He completed his course at the University and is at this moment at an eastern port ready to take his place beside the key with an invincible fleet or on our fast growing merchant marine.

"The school at Cincinnati has been a wonderful help," he wrote his father, who is attached to the Cincinnati Post Office Inspector's office.

Millionaires were no exceptions when the multitudes of red-blooded youths thronged to the service. Shoulder to shoulder at the school with sons of ice wagon drivers and bakers, for six weeks, was Cornelius J. Hauck, son of Louis Hauck, millionaire Cincinnati brewer. Young Hauck—he is 23—is about to graduate from a field in Tennessee as a bomber in aviation. He writes that the knowledge he received in Cincinnati helped him marvelously.

* * * *

And so the wheels of learning have ground; minds have been moulded and careers shaped with each daily revolution.

The old building has recently been painted. But the paint is only a weak, outward manifestation of the remarkable change on the inside.

The halls still brouse in semi-darkness, a reminder of the days of disuse before the war, but the rooms are a living, quivering example of bustle and life. Here is a tailor, worth $200,000 in his own name, vainly trying to catch the meaning of the whining jerks of the instrument, operated by a $15-a-week shoe clerk. Shoulder to shoulder they are, a room full. Here is Fred. W. Dearness, a school principal in the daytime, instructing Jim Brown, the cobbler's son, and doing his utmost to knead Brown's brain so Uncle Sam will benefit. The boys' faces, for the most part, are stern, and it doesn't take a super-imagination to transplant them to a ship, or a battlefield, or an airplane.

And as one passes from the busy room, the hums, and slurs, and buzzing notes, charge the air with a vibratory message of conquest to come. The sharp notes of the telegraph key are heard, from other rooms, where girls are learning to take the places of the men who go. And the many typewriters with their clatter almost make the place sound like a business college.

Hustle and hurry—and for what? For Uncle Sam; for you and me; for democracy. The old school, the busy students, everything, all are but a remarkable example of the adaptability of the schools of the land of the Stars and Stripes to meet a crisis—and meet it with vigor!

Torpedoed!

(Continued from page 18)

of our sailors and firemen who could not withstand temptation broke into the cargo of dried fruit, for which they were put in irons. Our coal supply was about exhausted and the captain decided to change our course and steer for Bermuda, where we could replenish the bunker.

On January 13th we had another alarm! We sighted what appeared to be a submarine ahead of us, rolling about in the sea. Upon drawing nearer we found it to be a submarine chaser flying distress signals and the flag of France. As we drew alongside, S. C. 171 could be distinguished on her bow. The captain ordered a lifeboat lowered and an officer went aboard the chaser.

There were twenty Frenchmen aboard. They were weak from the want of food. Some of them were so near starvation that they were unable to stand.

From what information we could gather from the officer we learned that they had become separated from their escort in a terrific gale. Their engines were disabled and

(Continued on page 43)

World Wide Wireless

(Continued from page 9)

A Job For Retailers in Electrical Supplies

THE big guns at the front are mounted on money. Don't forget that! And they will hold the enemy back only so long as their foundations last. Don't forget that!

This war cannot be carried on on loyal sentiment and armchair strategy. It has got to be carried on with big armies, powerful guns and everything guns and armies need for continued action.

War Savings Stamps will furnish the money provided retailers enlist their salesforce at full power to sell the stamps. Some of them have more salespeople at command than a regimental commander has fighting men. Just think a moment of the selling power of a store as big as that. Just think of the stamps it could sell if it worked only 15 minutes a day. And the smaller stores can do as well in proportion.

Ask your local dealers to put in a Thrift Stamp Department today if they haven't already done so. And then push the stamps!

Enrollment in Radio Sergeants School Open

"SCORES of German machine-gun nests hidden in this wood stopped the advance of our troops, but the American artillery opened so hot and accurate a fire that the majority of them were silenced; the infantry then rushed the others," is often the wording of an official communique from the front in France.

There must be accurate observation, correct transmission of information back to the artillery headquarters, calculation of the range and direction at which to set the guns; and the rest is simple.

Observations far behind the enemy lines are made by airplane. The aerial observer has a wireless sending set, and back near headquarters there is a radio sergeant with a wireless receiving set. As soon as a message is received at headquarters it is telephoned to all batteries firing or about to fire on that target.

Telephone lines connect each battery with its headquarters, and each headquarters with the next higher in the chain of command. These telephone lines have been constructed and are maintained under all difficulties encountered in modern warfare by the electrician sergeants. These electrician sergeants also operate the searchlights used in night operations against hostile aircraft and bodies of troops.

Every time a gun is shifted, its location on the map must be accurately determined by survey and triangulation. It takes a specialist to do it and this specialist is an enlisted man trained as a master gunner.

These radio sergeants, electrician sergeants and master gunners are being trained for this service in a twelve weeks' course at the coast artillery school at Fort Monroe, Va. Hundreds of men are being turned out in every class.

Any civilian, whether he be subject to draft or not, or any enlisted man now in the service, is eligible to enroll for this course of training and attend the coast artillery school, provided he has the proper qualifications, physical and mental.

The physical qualifications are those required of all recruits for general service. The mental qualifications are outlined in a bulletin issued by the coast artillery school, which may be had for the asking. Requests for this information may be made of the director, Department of Enlisted Specialists, Coast Artillery School, Fort Monroe, Va.

Daughter of Morgan's Partner an Inspector

AMONG the first of the wealthy women of America to don overalls and accept manual toil was Miss Alice Davison, daughter of H. P. Davison of J. P. Morgan & Co. and the American Red Cross. For $20 a week Miss Davison works every day as radio inspector in a wireless factory in upper New York.

Miss Davison, who is only twenty, explained that her purpose was to release a man for the front. She is one of a group of young women who took a special course of instruction as radio operators.

Wireless Equipment for Lightships

BRENTON'S Reef lightship, off the south end of the island of Rhode Island, has been equipped with wireless apparatus for the first time as the outcome of the German submarine raid. The announcement of the fact calls attention to the stupid neglect of the past. The loss last winter of Cross Rip lightship and the fact that its crew had no means of radio communication emphasized a lack of liberality and progress in the lighthouse establishment, or perhaps in congressional provisions, and warranted the belief that before this time all of the off-shore light stations would be provided with modern means of calling for assistance or rendering aid to mariners in distress.

If it was necessary for the submarine raider to enforce a lesson that even the loss of the Cross Rip vessel and crew failed to teach, then we owe something to the imperial German navy.

Perhaps some allowance must be made for war conditions in explaining the delay in supplying radio equipment for the lightships, but the war makes the improvement more necessary now than in peace.

Marconi Marine Co. Earns Over Two Million

DURING 1917 the business of the Marconi International Marine Communication Company increased by nearly 100 per cent. in gross revenue, according to the directors' report which has just been issued.

The gross revenue for 1917 amounted to £470,657, an increase over the preceding year of £200,476. This increase was derived principally from rentals of additional ships fitted. However, it is pointed out that necessary restrictions in respect of private messages at sea have continued and prevented revenue being received from this source.

The profit for the year amounts to £192,055, and from this figure is deducted £50,000, being a necessary allowance for obsolescence of plant, leaving a net profit of £142,055. During the preceding year the net profit amounted to £96,748. The improvement is about proportionate to the increase of the business. The balance of the debenture reserve account and the balance of share premium account have been transferred to general reserve, which now amounts to £258,009. The losses sustained in consequence of attacks upon the mercantile fleet during the year 1917 have been debited to profit and loss.

The total number of public telegraph stations owned and worked by the company on the high seas increased from 1,472 at the end of December, 1916, to 2,265 at the end of December, 1917. The organization of the company, together with that of its associated companies, with a total of some 4,000 mercantile vessels fitted with Marconi telegraph stations, has continued to render inestimable service, says the report.

The directors recommend a final dividend of 10 per cent., which, with the interim dividend of 5 per cent. paid in February, will make 15 per cent. for the year. The Amalgamated Wireless (Australasia), Ltd., in which the company is interested, has paid a dividend of 5 per cent. in respect of the year ending June 30, 1917.

Crack Austrian Naval Operators Arrested

AGENTS of the Naval Intelligence Service on August 31st picked up two wireless operators who, it is alleged, came to the United States on the steamship Martha Washington of the Austro-American Line, which sailed from Trieste on July 18, 1914, and took them to the New York Port Alien Enemy Bureau, where the men were questioned by Chief Examiner Perry M. Armstrong.

The men are George Fergal, a warrant officer in the Austrian navy, born at Klagenfurt in 1893, and Guido Gassa, born in Vienna in 1886, who enlisted in the Austrian navy when 16 years old, but claims to have received his discharge in 1909.

They were taken into custody when it was discovered, it is alleged, that they are still receiving pay from the Austrian Government and that both are well acquainted with the confidential code of that Government.

Fergal has three brothers now in the Austrian army and one brother has been killed in the present war. He enlisted in the Austrian navy in 1911 and became a wireless operator, serving on various ships of the navy. He was then put on duty handling the confidential code of the Government at a land station.

In July, 1914, after war was declared, he was assigned, it is alleged, to the Martha Washington by the "Funken Telegraf Inspectory." Papers in his possession indicate that he belongs to the "Imperial and Royal Wireless Department of the Austrian Navy."

Gassa, who is said to be the best wireless operator in Austria, speaks six languages—German, Slav, Italian, Bohemian, Spanish and English. He was assigned to various naval vessels. His claim is that he got his discharge from the navy in 1909, but this is doubted by the Federal officials. He, too, it is said, was assigned to the Martha Washington by the Funken Telegraf Inspectory.

The Martha Washington, which reached here on August 2, 1914, was interned. The operators remained aboard the steamer at Staten Island until it was taken over by the United States.

Since April 24, 1917, it is alleged, the Austrian Government has been paying the two wireless operators through the Transatlantic Trust Company, which was taken over by the Alien Property Custodian a few weeks ago. Gassa has been receiving $70 a month and Fergal has been paid $55 a month it is said.

Navy's News a Daily Radio Feature

EACH night the Navy Department sends out from Washington a wireless news service, "The Navy Press," to all ships and coast radio stations. The message ranges from 800 to 1,600 words in length and contains items of general and particular interest to officers and seamen in every branch of the naval service. Each day the budget of news is carefully sorted and the more important events are put into concise English. During the night the words are flashed out by the Government's radio operators, and next morning there appears upon the ship's bulletin boards a résumé of all the previous day's happenings, both abroad and at home.

No cipher is used and the process is known as "broadcasting." It goes out to any and every vessel, battleship or merchantman, whose radio instrument is tuned to receive it.

On small ships one bulletin board is usually enough to contain the news for those aboard. On a large man-of-war there may be ten or even more. One is ordinarily placed in the ward room, one in the junior officers' mess room, one in the warrant officers' mess room, and one in the chief petty officers' mess room. Several bulletin boards for the crew are located in convenient gathering places about the ship. Besides the bulletin boards, a copy of the news letter is given to the ship's commander and, if there chances to be an admiral on board, a special copy is prepared for him also.

The news needs of men aboard a battleship are as various as their tastes and dispositions. All are interested in war developments, but each seaman also has his particular hobby. One is eager to know what is happening in the theatrical world, another is chiefly concerned with the fluctuations of the stock market. The United States Navy Press Service recognizes this divergence of interests and caters to the different wants.

Closely related to the interest in market reports is the desire of the sailors to know about the financial standing of Government bonds. A great many of them own Liberty bonds. Although they feel sure of the security of their investment they like occasionally to be reassured.

Baseball, the national sport, is constantly in the minds of the boys at sea. Although they are unable to play while cruising (for the deck of a ship is a poor place to knock flies and swat out three-baggers), they flock eagerly to the bulletin boards to read notices of the games of the landlubbers. When the big-league season opens, reports of all the important games become a regular feature of the service. When a world's series is on, or a decisive game is to be played near the end of the season by closely matched teams, special wireless messages are sent out for the information of the jack-tars.

Contemporary Editor Taltavall Dies

THOMAS R. TALTAVALL, aged sixty-three years, editor of Telegraph and Telephone Age, New York, died at his home at Mahwah, N. J., on September 2nd of heart disease, after an illness of several months.

Mr. Taltavall learned telegraphy at Wellsville, Ohio, in 1867 and soon developed into one of the most expert telegraphers in the country, being employed in many of the larger offices. He was selected as one of the original operators to man the first wire leased by the Associated Press to carry the newspaper service between New York and Washington in 1875, and was assigned to the Washington, D. C., Bureau. He was soon after transferred to the New York office, with which he remained fourteen years, in the latter eight filling the position of superintendent of the leased wire system of the Associated Press. In 1890 he resigned to become editor of the Electrical Age. In 1894 he became associate editor of the Electrical World, which position he held until 1911, when he accepted the editorship of Telegraph and Telephone Age. Mr. Taltavall was the inventor of many useful electrical devices and was one of the best-known writers of electrical literature in the country.

Chinese To Have Wireless Telephones

THE Chinese Government has made an agreement with the English Marconi Company to purchase wireless telephones at a price of £300,000. The telephones are to be delivered within nine months. The price will be deducted from a loan of £600,000 at 8 per cent.

The Government has received advances which make possible a resumption of the fighting against the South, which recent events had rendered doubtful.

Finding Your Way Across the Sea

The instruction series by Capt. Uttmark which has been running in The Wireless Age has been interrupted by the pressure of work on the author, who is engaged in training men for the Government. The suspension of this feature for an indefinite period is therefore regretfully announced.

The Editor.

Progress In Radio Science

(*Continued from page* 14)

and one anode. Each cathode is connected to the negative terminal of a high voltage source of direct current through a large inductance and a resistance; and the anode, likewise through an inductance to the positive terminal. An oscillatory circuit is shunted between the cathodes.

In figure 1 the arc generator is furnished with direct current, but in figure 2 it performs the combined function of rectification and generation being fed by an alternating current dynamo.

nately carry the main current through the tube, they may be called "arcing cathodes." Inductance 7 and resistance 9 may be conveniently combined into a single coil having proper inductance and resistance. Likewise 8 and 10. Inductances 2, 7 and 8 should preferably be wound so as to have a minimum distributed capacity. An oscillatory circuit, comprising, for example, a condenser 11 and inductance 12, is connected between the cathodes as shown. The tube may be started in a variety of ways. The method

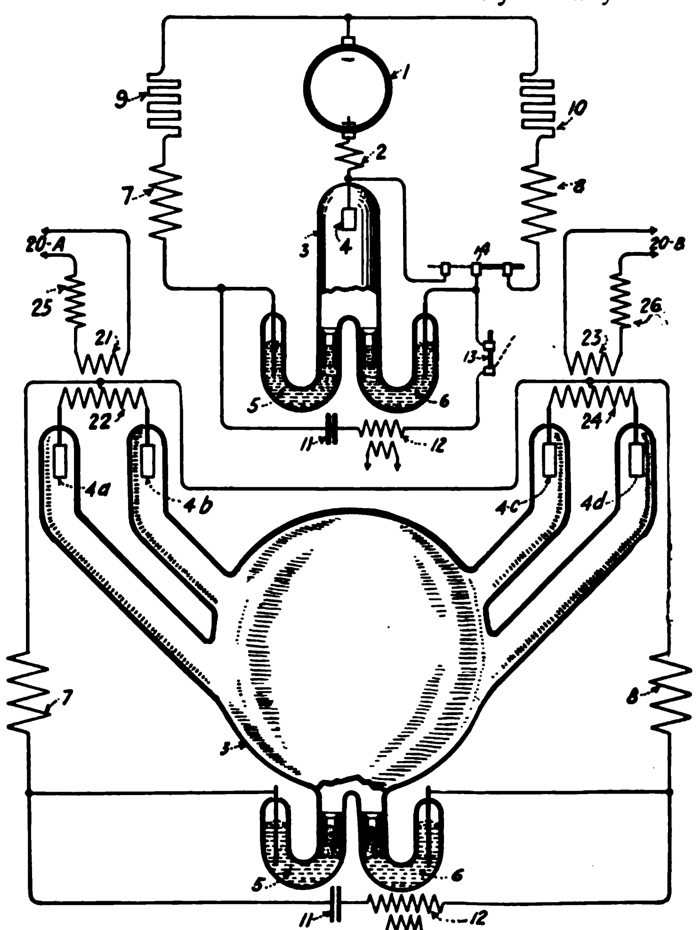


Figure 1 (Top)—Showing mercury arc generator furnished with direct current
Figure 2 (Bottom)—Mercury arc generator fed by an alternating current performing combined function of rectification and generation

Referring to figure 1 a source of high voltage direct current such as a high voltage dynamo, is shown at 1, with plus and minus terminals as indicated. To prevent high frequency energy from getting back into the supply circuits, an inductance is provided such as is shown at 2, although any other suitable means may be employed for this purpose. 3 designates a mercury vapor tube having an anode 4, and two mercury cathodes, 5 and 6. Cathode 5 is connected to the negative terminal of 1 through a large inductance 7 and a resistance 9, and cathode 6 is likewise connected through the inductance 8 and resistance 10. Since these cathodes alter-

shown here is as follows: A switch 13 in the oscillatory circuit is opened, and a double throw switch 14 is thrown to the left. These positions are shown by the dotted lines in the figure. The cathode 6 is thus temporarily made a starting anode, and by tilting the tube in the usual manner, the discharge through cathode 5 is started and will be maintained. Switch 14 is now thrown to the right, the position shown in the drawing by the full lines, and if the tube is again tilted, cathode 6 will be started. Two such parallel discharges are ordinarily highly unstable, but if each cathode is supplied through a suitable induct-

ance, as shown, the parallel discharges are rendered stable and will run indefinitely under suitable conditions.

The stability produced by the inductance in series with each cathode is destroyed if a condenser is shunted across the cathodes and it is owing to this fact that the system can be made to oscillate. One mode of operation is as follows:

Suppose that the parallel discharges are operating steadily, the switch 13 being open. Let this switch now be closed (position shown by the full lines); the stability of the parallel discharges is destroyed, and one of them, say that through 5, will be extinguished. The current through inductance 7, which formerly went through 5, must now take the path from 4 through 6, 13, 12, 11 and 7; that is, the inductance 7 now begins to discharge itself into condenser 11. In a very short time the condenser attains a voltage, say V, sufficient to start a discharge in the tube between 5 and 6, hence the oscillatory circuit begins to execute an oscillatory discharge around the path 11, 12, 13, 6, 5, 11. Discharging under ordinary circumstances the condenser would attain at the end of the first half-swing a voltage (V-v) which is reversed in sign to the original voltage V and smaller in value than V. But as soon as the condenser circuit begins to discharge through the tube, cathode 5 is started again and cathode 6 extinguished. The current through inductance 8 must now pass through cathode 5, hence while the oscillatory circuit is executing its first half-swing, inductance 8 is discharging into condenser 11. At the end, or shortly before or after the end, of the first half-swing, therefore, the condenser voltage will not be —(V-v) but —V, which voltage is sufficient to start the reverse discharge between 5 and 6. The condenser circuit now begins to execute its second half-swing, starting cathode 6 and extinguishing cathode 5 again. The condenser voltage tends toward the maximum value (V-v), but the inductance 7 must now discharge into the condenser, so that the voltage V is reached again, and the process repeats itself.

When the system is operating in the manner described the oscillations produced are undamped and practically sinusoidal. The system may oscillate in other ways, however, giving for example rapid series of slightly damped waves, or other types of waves. The manner in which the system oscillates is determined by the magnitude and character of the various constants which enter into the circuits.

In the drawing the cathodes 5 and 6 are shown constricted where the discharge enters them. The cathodes are preferably in this form because better results have been obtained with them than with mercury pools of the ordinary type.

It is found by experiment that in order to obtain steady oscillations the ratio of inductance to capacity in the oscillatory circuit must be very large. The oscillatory circuit can be connected or coupled to the antenna or other circuits in any desired manner; and, under proper conditions, the antenna itself may be the oscillatory circuit or part thereof.

This system may be adapted for use with alternating current supply. Single phase may be employed, but polyphase currents are preferred. Referring to figure 2 which shows the invention adapted for use on a two-phase system, 20A and 20B indicate the two-phase supply, 21 and 23 are the primaries of a pair of transformers, 22 and 24 are the secondaries of the same. The primaries are supplied through the series reactances 25 and 26. The tube 3 is provided with four anodes, 4a, 4b, 4c and 4d. Special care is necessary to prevent arcing between these anodes. The terminals of 22 are connected to anodes 4a and 4b, those of 24 to 4c and 4d. The mid-points of the secondaries 22 and 24 are connected together, and from these midpoints run the parallel paths 7, 5 and 8, 6. The significance of these and the remaining members is the same as in figure 1. In order not to complicate the figure, starting means are not shown. The tube may be started as shown in and described in connection with figure 1, or in a variety of other ways. It is understood, of course, that means are provided for preventing high frequency energy from getting back into the supply circuits.

It will be observed that the extra resistances 9 and 10 of figure 14 are not shown in figure 2 and that series reactances 25 and 26 are shown in figure 2, through which the primaries are supplied. The reason for this is: In figure 1 the extra resistances are necessary in order to limit the starting current, that is the current drawn by the circuits after the parallel discharges are started and before the oscillations have been set up. In figure 2, however, where alternating current is employed the starting current is limited by the series reactances 25 and 26, hence only small series resistances are necessary; hence the form shown in figure 15 is more efficient than that in figure 1. If the transformers of figure 15 are constructed to have sufficient leakage, then the series reactances are unnecessary. All that is necessary is a loose coupling between the primaries and secondaries of the supply circuits.

Aviation News

(*Continued from page* 20)

only be obtained by bulk orders permitting a high degree of sub-division of work.

"The problem is complicated by the fact that manufacture and delivery rarely if ever proceed in accordance with anticipation. The output of a particular type may be delayed for weeks or even months owing to some technical difficulty of manufacture. Moreover, as replacement of losses and expansion are proceeding simultaneously in the flying services, and the rate of wastage in different types of engines and of aeroplanes varies considerably according to circumstances, it is impossible to forecast with accuracy what engines will be available for the equipment of new types of aeroplanes after wastage has been made good. Nor is it possible to any great extent to adjust the programme by modifying orders once placed without disorganizing supply. The problem does not end here. Whenever a new type is introduced provision must be made for accumulating a sufficient 'head' of spare engines, spare aeroplanes and spare parts of innumerable kinds, to keep the squadron to be equipped with that type in a condition to make good the day-to-day wastage and carry out the constant repairs required."

Attention was drawn, on more than one occasion, by manufacturers to the importance of maintaining the interest of workers in aircraft factories in the highly important but generally monotonous work on which they are employed. Engaged, as they frequently are, on the production by a repetition process of some small part of an aeroplane, these men and women find it difficult to realize that they are contributing effectively to one of our most valuable instruments of warfare. It was accordingly arranged that Captain Ewart, R. A. F., well known as a writer by the name of "Boyd Cable," should visit various squadrons at the front and gather materials and photographs for lectures concerning the exploits performed with various types of aircraft for delivery to the workpeople engaged on the manufacture of those particular types. Captain Ewart delivered several series of lectures which, judging from the reports received from the factories concerned, proved a very great success.

Electrical Digest

The Production of Nitrogen From the Atmosphere

THERE has been erected at the United States Department of Agriculture's Experiment Farm at Arlington, Va., the largest experimental plant in the United States for the production of nitrogen from air. The nitrogen so produced is combined with hydrogen to form ammonia, which can be used in the manufacture of explosives and fertilizers. Experiments with the view of increasing the efficiency of the process are now being conducted by the Bureau of Soils. The Haber process of manufacturing nitrogen is being employed. This process involves the production of ammonia from hydrogen and nitrogen. The two gases are mixed in the proper proportion, put under high pressure, and subjected to intense heat. They are then passed over a spongy iron, whereupon a portion of the mixture combines to form ammonia.

The Aluminum Production of the United States

THE United States is far in the lead among the Aluminum producing countries of the world. In fact about one-half of the world's output is produced in this country.

A recent compilation by the National City Bank of New York shows that the production of aluminum in the United States has grown from 60,000 lbs. in 1890 to 7,000,000 in 1900, 48,000,000 in 1911, 100,000,000 in 1915, 140,000,000 in 1916, and approximately 180,000,000 in 1917.

It is stated that aluminum is proving an acceptable substitute for tin in the metal industries. Its cost is no greater than that of tin, which is an important matter to the United States, because this country produces no tin and purchases large amounts abroad.

Most of the aluminum produced at present in the United States is employed in aeroplanes, automobiles, helmets, and cartridges.

Pauxite, the mineral from which the aluminum is produced, is found in many parts of the United States, but the bulk of it is furnished by the State of Kansas. The finished product is made in various parts of the United States, the most important plants being located at Niagara Falls, N. Y.

The Monthly Service Bulletin of the NATIONAL WIRELESS ASSOCIATION

Founded to promote the best interests of radio communication among wireless amateurs in America

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THE proposed extension of the draft ages to include men from 18 to 45 years, calls for serious attention on the part of former amateurs in the United States, particularly those who were below age in the first call.

An increased army naturally will require an increased number of radio engineers, operators, mechanics, repairmen, and installers. Amateurs approaching the age of 18 and up to 21 years ought to take full advantage of their spare time, and prepare themselves for an appointment in the radio divisions of either the army or navy. This will mean an immense saving of time and labor to the government. Every means at their disposal should be grasped to gain a practical education in wireless. This can be obtained by joining a local radio school, or by forming a local radio club for the sole purpose of instruction in the theory and in the International Code.

A considerable amount of self education can be carried on. Literature is now available for the study of the art in all its phases. Code practice outfits are inexpensive, and the Marconi-Victor Records can take the place of a special instructor. It is not difficult for the beginner to master the fundamental principles of wireless transmitting and receiving apparatus if he will first make a thorough study of the elements of electricity and magnetism. By close application, he will finally arrive at the point where he requires instruction on actual equipment. A radio school will generally be found within a reasonable distance.

It is safe to say that the new draft will include thousands of wireless operators, therefore, why not start instruction today. Putting it off will never do. Skilled men are the requirement of the hour. The selected man should not wait until he has been assigned to a cantonment. He should go to camp with a complete mastery of the basic principles.

His expertness will come under the observation of some superior officer sooner or later, and before he believes it possible, he will receive a higher appointment.

The amateurs of this country have responded nobly to the government's call for volunteers. It is next to impossible to locate a former well-known experimenter. He is either in the front ranks with Uncle Sam's Army or in the laboratory doing research work in radio. Many have received commissions, rapid promotion being possible because of the experience gained through their home experiments.

A man in charge of a large government school told the writer recently that students who were formerly amateur experimenters, outshine all others from every standpoint, and he expressed the desire that the government would in the future pay particular attention to enrolling first, young men who had operated experimental wireless stations in years gone by. He declared that they possessed a certain keenness in manipulating wireless equipment which the land line telegraphers required several months of close application to acquire.

In preparing themselves for government service several inquiries have been received from various amateurs which in a general way may be stated as follows: "What shall we study to fit ourselves for government radio work?" To this we reply that that aspirant should master first the International Telegraph Code. He should follow this by study of elementary electricity and magnetism; next—the alternating current dynamo and transformer. He should learn how to use measuring instruments, and afterward take up the radio frequency circuits of the wireless transmitter and receiver.

The process of tuning is next in order; then the principles and operation of the vacuum detectors. He should study the fundamentals of un-

damped wave transmitting and receiving apparatus particularly, the arc transmitter and the beat receiver.

Within a space of three to six months, the beginner should acquire a fair general knowledge of wireless telegraphy, and then by taking a finishing-up course at a properly equipped radio school, he will be a well-balanced radio man. The foregoing deserves serious consideration.

The following is a statement of fact, but for reasons well known to ourselves, the proper names of the gentlemen involved cannot be published:

Bill Jones and John Smith lived on the same block, and both were deeply interested in amateur wireless telegraphy. Jones constructed a haphazard station without giving serious attention to basic principles. He used his apparatus merely as a toy, the major portion of his time being spent in filling the ether with nonsensical conversations. He never studied a book on radio and sidetracked all attempts to study the theory underlying the working of his apparatus. Like many others in the same class, his interest waned until his station was only heard occasionally.

John Smith, on the other hand, read every piece of available wireless literature, and he conducted a series of experiments to determine the how and why of his apparatus. He built his instruments in accordance with well-known principles, and every test he made was for the purpose of making a new determination. He was often laughed at by Jones for taking the art so seriously, but nevertheless he plugged away until his station had a reputation of being the best in that locality.

Both of these gentlemen being within the draft age, they decided to enlist in the Navy as radio operators. Jones enrolled in this particular division because he thought that he was going to take on "something easy," but Smith entered with the sole idea of doing the greatest possible good to the Government. They joined a prominent Naval School at the same time and were placed in the regular routine. Jones held that if he became a fair wireless operator he was doing his part, at least in the eyes of the neighbors in his home town, but Smith had a larger vision, and he did everything possible during his training period to further his knowledge of the art.

To make the story brief, Smith is now a Radio-Gunner in charge of wireless operations on one of the largest vessels in the Navy. Jones is a third-class electrician on a merchant transport, and the chances are that he will continue in this capacity for the duration of the war.

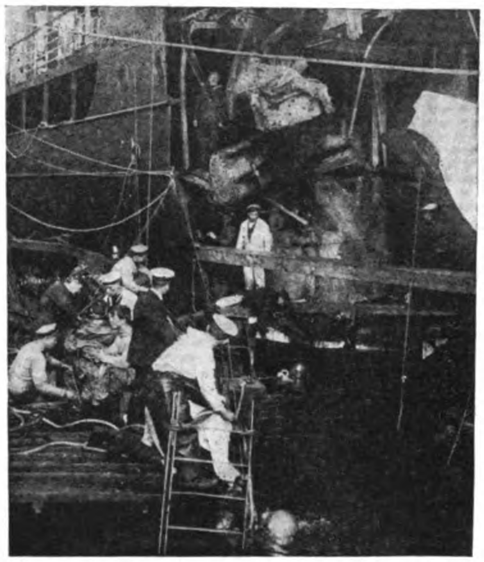
Would you rather be Jones or Smith? If Smith, then go back and read the first article in the bulletin again.

Torpedoed!

(Continued from page 35)

the men were without food for eight days. They had even eaten the cats that were on board. The crew had given up all hope of being rescued, as several ships had sighted the chaser but thought it to be a submarine and changed their course.

A lifeboat filled with food supplies was sent out to her. We then took her in tow and continued on our voyage. This happened by coincidence



Divers at work searching for the bodies of firemen who lost their lives

on my birthday—the 13th, surely for the Frenchmen, a lucky 13th.

Later we learned that there were seventeen of these U-boat chasers built in the United States for France, and only eleven reached port.

We arrived at St. Thomas, Bermuda, two days later with the S. C. 171 safely in tow. She was taken in by a tug and I have heard nothing further concerning her. After coaling, our voyage to New York was resumed without further incidents.

Lack of skill in story-telling has probably made this a pretty poor yarn, but I am hopeful that in it readers will see that submarine attacks are still one of the grim features of the present war. We wireless operators have our trials at sea just as frequently as do those who are fighting "Over There." But the knights of the sea roads are winning their victories and the spirit of '76 assures a certain triumph. America's day on ocean cross-roads is coming; soon the Hun must seek shelter. And when we have the upper hand, well—if Sherman thought war was hell, the Kaiser's opinion surely will not look well in print.

Harvard Radio School

Uncle Sam is sending out every week from fifty to one hundred wireless operators from the big Harvard plant at Cambridge, Mass., which was transferred to the Government a year ago as a radio finishing school. It is the only institution of the kind in the country, and the classes have in the aggregate 5,000 ambitious youths.

Memorial Hall, perhaps the most famous of all the Harvard buildings, and wherein generations of undergraduates have dined, is the main eating establishment for the radio army.

But this old hall has its quiet period, for on payday, which comes twice a month, only a handful go there to dine. The radio boys walk with the "ghost" and go him one better by taking an eight minute subway jump to Boston, where they come up for air and a change of scenery.

The radio students notably are orderly. They are scattered over a wide area, many of them lodging in private homes without official restraint, yet police and military records reveal blank blotters so far as they relate to radio students.

This being a finishing school, only those who are able to copy ten words a minute in the Continental code are admitted for the sixteen weeks course. To be sent out for service at sea they must be able to receive twenty-two words a minute, the minimum grading. There are many experts among the teaching force whose speed runs up to thirty-two words a minute, but beyond that a radio message would be hard to get. From three to six operators are assigned to each ship. With the large number of vessels building for the merchant marine and the navy, the radio school is doing its best to turn out experienced operators as fast as possible.

The radio men have come from every State in the Union, many of them under draft age, and generally eager for active service.

Warming the Aviator's Feet

ELECTRICAL means of keeping an aviator's feet warm is the basis of a new apparatus recently devised by a New York inventor. The illustrations show the arrangements.

This shoe-warmer equipment comprises an insole having the general appearance of the commonly used slip insole, except for the two plugs projecting about one-eighth inch from the bottom.

When the insole is placed in position in the shoe, the two small plugs fit in two sockets which are sunk about one-eighth inch in the heel. These sockets are the terminals of two small insulated wires, which are connected to the terminals near the top of the shoe. These terminals may be made invisible if desired.

Electric current is brought to the terminals through small insulated wires attached to the inside seam of the trousers; these wires connect with the source of electric current at the waist so that there are no loose wires to inconvenience the wearer.

The amount of current consumed is very small indeed, two ordinary sized flashlight batteries being sufficient to keep a person warm for a number of hours.

While it was to give aviators a practical means for keeping themselves warm that brought about this invention, its use is not by any means restricted to aviators' needs. Look-outs

Showing method of wiring

on naval patrols, submarine crews, observers in observation balloons, soldiers convalescing, motor car and motor truck drivers, and all others who are subjected to the rigors of outdoor life can use this simple equipment to advantage.

An obvious application would be to our troops operating in the arctic region of Siberia this winter, whether fighting or convalescing. The man using this equipment is not only going to be kept comfortable, he is going to be very much more efficient.

It would seem also that this invention will prove of great value to the man about town this winter. Some of us will not have all the coal we would

like to have, so that other means will have to be resorted to. From a coal-saving and economic point of view, this idea can't be beaten, the inventor claims; by using one's electric lighting circuit, the feet (which affect the temperature of the whole body) can be kept warm for about 1 cent a day. Not only can a person be kept comfortably warm in this way, but they may enjoy fresh air at the same time; windows need not be sealed up in order to retain the warmth, the stale and injurious air which is the general rule with every other heating means being dispensed with. Thus lungs are kept strong and in a condition to resist the extremely cold air of outdoors. It is well known that more colds, pneumonia and grippe are brought about through people going out into the cold air after sitting for some time in a carefully closed-up office or room than by any other means. The shoe-warmer equipment is expected to do away with this danger.

Style of insoles with wiring and contact points in place

Queries Answered

Answers will be given in this department to questions of subscribers, covering the full range of wireless subjects, but only those which relate to the technical phases of the art and which are of general interest to readers will be published here. The subscriber's name and address must be given in all letters and only one side of the paper written on; where diagrams are necessary they must be on a separate sheet and drawn with India ink. Not more than five questions of one reader can be answered in the same issue. To receive attention these rules must be rigidly observed.
Positively no Questions Answered by Mail.

F. R. D., Mobile, Ala., inquires:

Ques.—(1) Up to the time of the United States' entrance into the war, what was the most commonly used type of oscillation detector?

Ans.—(1) It may be said that the carborundum rectifier was the most popular up to that period, due mainly to its simplicity, ruggedness and stability. Vessels fitted by the English Marconi Company usually include a magnetic detector with the radio equipment. This is by far the most stable and fool-proof of all oscillation detectors, but it possesses the disadvantage that it is not sensitive on the shorter range of wave lengths. Its reliability in operation, however, offsets its shortcomings in that respect. The two and three-electrode vacuum tubes were favored up to that time, but were expensive to build and operate as compared to the simple crystal.

Ques.—(2) I have noticed that there are a variety of methods of connecting the potentiometer and battery to the carborundum rectifier. Which one is preferable?

Ans.—(2) There are three methods of connection as shown on page 134 of "Practical Wireless Telegraphy." The connection generally favored is that of Fig. 153b. Fig. 153c are the connections used by the English Marconi Company. The connections of Fig. 153a are now practically obsolete.

Ques.—(3) How does the operator obtain the best operating adjustment of the carborundum crystal?

Ans.—(3) If the receiving tuner is fitted with a buzzer tester, the buzzer is set into operation. The operator then tries various points of contact with the crystal with simultaneous adjustment of the potentiometer, until the loudest signals are obtained in the head telephone. It is difficult to give specific instructions in advance. Also remember that the current from the local battery must flow through the crystal in a definite direction. The correct polarity is readily determined by experiment.

Ques.—(4) What is meant by a "standby circuit?"

Ans.—(4) This is the circuit that the receiving operator employs when he desires to receive response from several transmitting stations operating on slightly different wave lengths, without accurate tuning. For "standby" work, the operator employs close coupling between the primary and secondary coils of the receiving transformer.

Ques. (5) In the circuit of the three-electrode vacuum tube, I often notice a resistance connected between the grid and filament. What is the function of this connection?

Ans.—(5) This resistance is employed to prevent an extraordinary negative potential piling up in the grid condenser, or on the grid itself. It can be shown that if the grid of the vacuum tube is charged to a sufficiently high negative potential, the plate circuit will open; that is, the passage of current from the plate to the filament will be obstructed. Hence, when a cascade amplifier is employed, it becomes necessary to connect a resistance between the grid and the filament of the vacuum tube, in order that the fluctuations of the grid potential in the second or third tube will not become so great as to render the vacuum tube inoperative.

* * *

A. B. L., Clarksburg, W. Va.:

We cannot publish details concerning the scope of instruction given at Naval Radio Schools. The Navy has both general schools and "finishing up" schools. The appointments which Naval students obtain depends primarily upon their rate of advancement. This is a matter on which we cannot give you much information.

* * *

G. R. L., Washington, D. C., inquires:

Ques.—(1) Assuming a short-wave condenser to be connected in series with a wireless telegraph receiving set; will the antenna system respond to the longer waves in the position of maximum capacity of the condenser or in the position of minimum capacity?

Ans.—(1) The shorter wave length adjustment will be obtained when the capacity of the condenser is near to zero. Moreover, this condenser will be

a greater determining factor in changing the wave length when its capacity is equal to or less than that of the wireless telegraph aerial.

Ques.—(2) When the statement is made that the decrement of a wireless transmitter is 0.2 what does this expression indicate?

Ans.—(2) The decrements of damping indicates the rate at which oscillations die away in a circuit producing damped oscillations. It is in reality an expression which shows the energy losses in a given circuit. A decrement of 0.2 signifies that each spark discharge in the closed circuit of the wireless transmitter sets up approximately 25 complete oscillations in the antenna circuit before the amplitude of the last cycle is .01 of the amplitude of the initial cycle. The logarithmic decrement of damping is the logarithm of the ratio of the amplitude of two successive oscillations in a wave train in the same direction; that is, it is the decrement per complete cycle.

Ques.—(3) Can you give me a simple explanation of what is meant by a quenched spark?

Ans.—(3) The phenomena of quenching is obtained to a greater or lesser degree with all types of spark gaps. A proper quenched spark gap is one that permits little or no retransference of energy from the aerial circuit back to the closed circuit. In other words a quenched spark gap permits the closed circuit to oscillate through 2½ or 3 cycles, after which the insulating qualities of the gap are restored and the oscillations are suddenly cut off. This permits the aerial circuit to oscillate at its own frequency and damping, and generally results in oscillations of feebler decrement than are obtained with spark discharges, in which the quenching feature is not so pronounced.

Quenching, in a sense, means rapid cooling of the gases around the spark discharge electrodes. If the gases cool so rapidly that the gap's insulating qualities are restored after two or three cycles of current, then the most effective quenching is secured. The most effective way of obtaining rapid cooling is to cause the spark to discharge between large copper plates, the sparking surfaces of which are separated by, say, 1/100 of an inch. Other means, however, may be used for cooling the gap.

Ques.—(4) How can the transmission range of a radio transmitter be predetermined?

Ans.—(4) Formulae has been presented for this calculation, but they are only approximations. The better way to determine the range of transmission is to conduct actual experiments to this end. Of course, engineers have made observations through years of experience, and they are enabled to predetermine with a fair degree of accuracy the probable range of transmission. In fact radio engineering has been reduced to a scientific basis, enabling practically all calculations to be made in advance. Local conditions, however, may upset the calculations, particularly in a region where there is considerable atmospheric electricity. The approved method is to construct a transmitter of more power than is required to cover a given distance. This permits communication to be carried on under adverse circumstances.

* * *

P. R. A., U. S. A.:

Ques.—(1) In the operation of our transmitting apparatus the aerial ammeter fluctuates badly, that is, if we depress the key, the pointer will jump from 6 to 10 amperes, and irrespective of how we adjust the apparatus this will continue. Have you any advice to offer?

Ans.—(1) This may be due to a variety of causes. The ammeter itself may be defective, that is, there may be leakage in the insulation, or the antenna wires may swing to contact with guy wires on the vessel. If a multiple quenched spark discharge is employed the insulating gaskets may leak air, and some of the plates are possiby short-circuited. If the brushes on the motor generator are making good contact, and the transformer is apparently in first-class condition, it would be well to take the quenched spark discharger apart, clean the plates, and install a new set of insulating gaskets. The plates should then be clamped in their rack with good pressure. The spark should then be allowed to discharge through the gap for a period of at least a half an hour. After this the set can be readjusted for resonance, until the maximum reading of the ammeter is secured. If this does not remedy the trouble, look for leakage in the insulation elsewhere.

Ques.—(2) In the advent that a frequency meter is not supplied with a radio set, how can the frequency of the generator be obtained?

Ans.—(2) A small speed indicator should be applied to the shaft noting the revolution per minute. Divide this by 60 to obtain the number of revolutions per second. Assume that the generator made 33⅓ revolutions per second, and it had 30 field poles. Then the frequency equals

$$\frac{33\frac{1}{3} \times 30}{2} = 500 \text{ cycles per second}$$

In other words, the speed of the armature per second multiplied by the number of field poles and divided by 2 will give the frequency of the generator.

Ques.—(3) How can we remedy sparking at the brushes of the motor?

Ans.—(3) Clean the brushes of the commutator thoroughly. If the commutator is grooved, remove the armature from the machine and have it turned down in a lathe. Be sure when replacing it that the brushes are placed in the neutral field. If the armature coils are not defective, this should remedy your trouble.

Ques.—(4) Can a carborundum crystal be used as an oscillation detector for undamped waves?

Ans.—(4) Not unless a local radio frequency oscillation generator is supplied. If, for example, a three-electrode vacuum tube is connected up for the production of radio frequency currents, and it is placed in inductive relation to the aerial circuit, beats will be generated in the receiver circuits, and they may be detected in the circuits of the carborundum rectifier.

Ques.—(5) Can a carborundum crystal be employed to take down wireless telephone conversations?

Ans.—(5) Any type of oscillation detector responsive to damped waves will be suitable for his purpose.

* * *

A. P. R., Student at a Naval Radio School, inquires:

Ques.—(1) I have often heard the expression "feedback" employed in connection with receiving apparatus in wireless telegraphy. Just what does the term mean?

Ans.—(1) This term is applied in connection with the regenerative circuits used with the vacuum tubes. In a feedback circuit, the plate circuit is coupled to the grid circuit either inductively, conductively or electrostatically, such a circuit is essentially the regenerative circuit first shown by Armstrong.

November, 1918

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The WIRELESS AGE

Volume 6

Number 2

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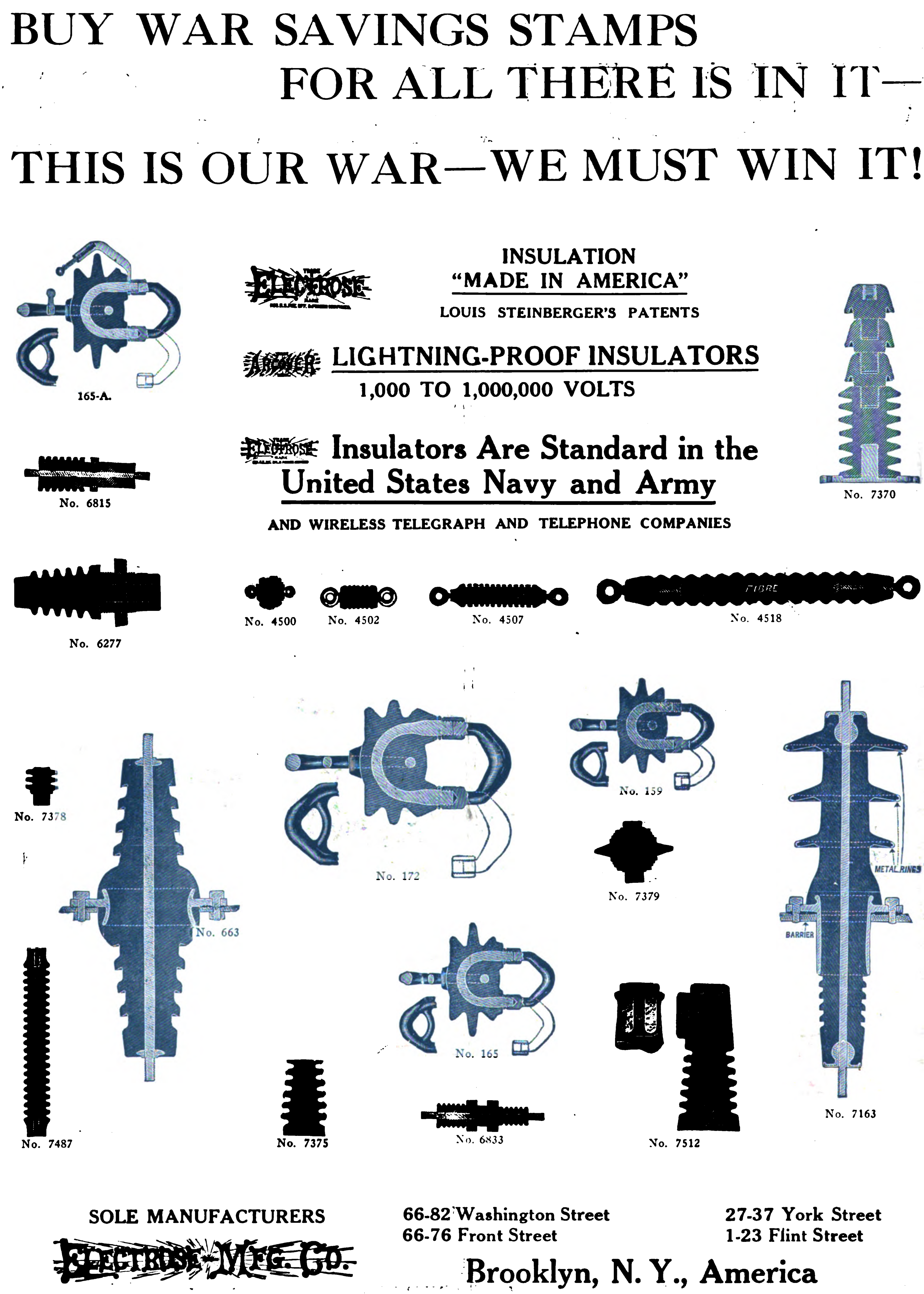
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The Wireless Age

Edited by J. ANDREW WHITE

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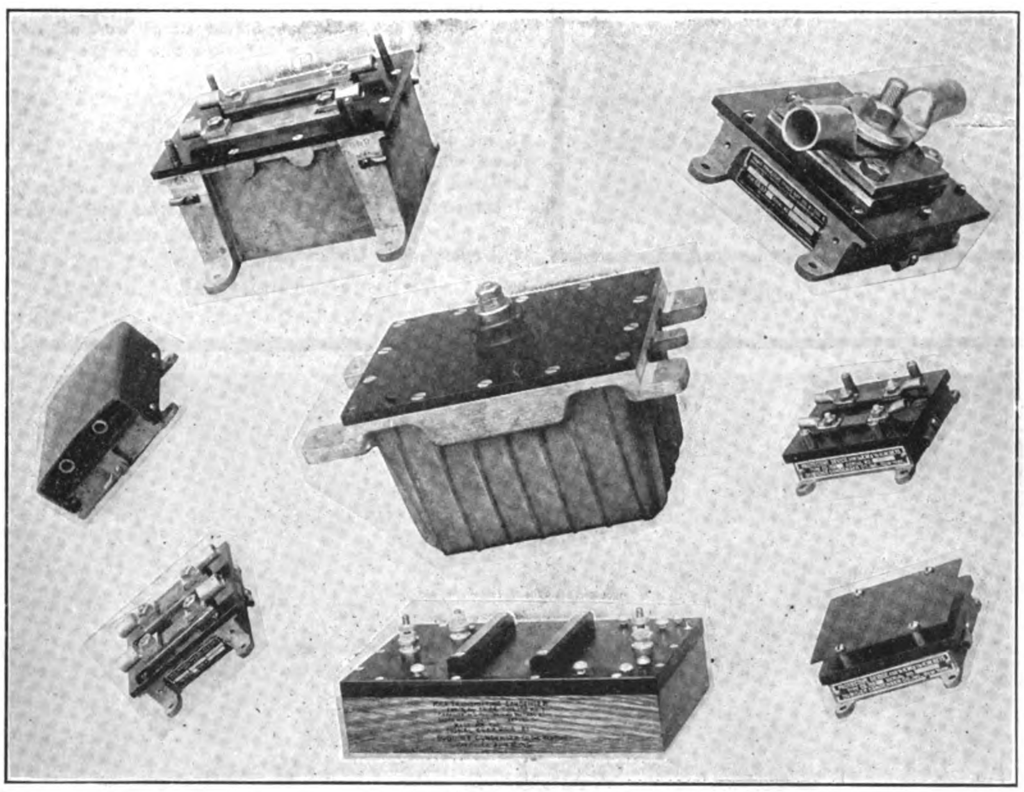

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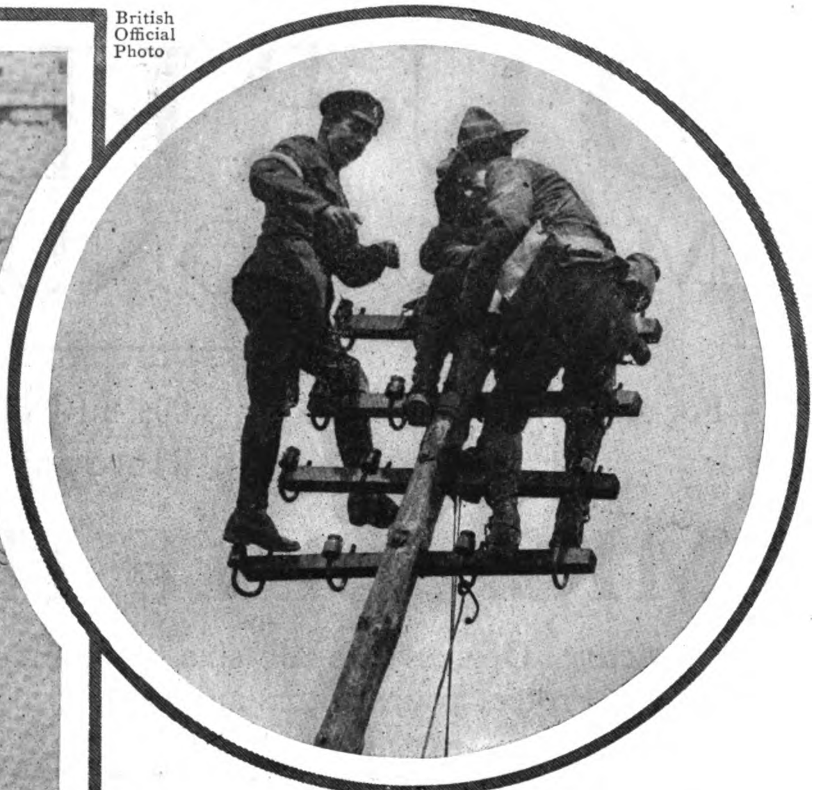


Above, in circle, the union of the allied armies visualized in members of both British and American Signal Corps working side by side in the construction of a telegraph line on the western front

To the left, protective armor for shock troops. The bullet-proof vest shown will stop revolver bullets at any range and resists shrapnel at 1200 feet velocity per second. It is flexible and scientifically made to protect the sides and abdomen and all vital organs of the body

(c) Underwood & Underwood

This photograph, an official one taken by the Signal Corps in France and released by the Committee on Public Information, shows how closely allied is electrical communication with artillery ranging in modern warfare. The battery captain, with the megaphone, is withholding fire of his field pieces until full data is received by the signalman at the foot of the tree

VOL. 6. No. 2. NOVEMBER, 1918

THE WIRELESS AGE

WORLD WIDE WIRELESS

Wireless Is Greatest Aid to Alaskan Education

A SCHOOL teacher's job in Alaska is anything but a bed of roses. Seventy native schools maintained by the government throughout the territory are in charge of men as resourceful as Charles N. Replogle, the government teacher at Norvik, who is required to make a study of the reindeer industry in addition to his hundred and one other duties.

The Eskimo is not as isolated as the geography would indicate, for at some of the schools wireless stations have been established and news of the world is flashed to them. Concerning his enterprise Mr. Replogle says:

"The greatest difficulty experienced in teaching the Eskimos is not in teaching them regarding the facts of life, but in getting those facts applied to their everyday living. Instruction has, therefore, been of the most practical kind. The morning exercises are largely taken up with singing and telling the wireless news from all over the world, as received at our wireless station. So eager are the people to get in touch with the world that it is common to have the schoolroom full of adults to hear the news. In order to understand it they must become acquainted with geography and history. These studies have given them a comprehensive viewpoint such as was never possible to obtain through the abstract textbook method of teaching. This has had much to do with the change of the customs of the people themselves. To them the United States and its government is no longer a matter of a man or two, but is a big tangible reality.

"The wireless has done more in one winter to awaken the slumbering intellect of the native than years of abstract bookwork. His education has come to him imperceptibly and has fastened itself upon the consciousness without definite effort on his part. There is no longer any balancing of the 'native custom' against the new knowledge. In room No. 1 a class was organized for the study of electricity and the "radio" code. With the very limited general knowledge of the pupils, the progress was necessarily slow and very tedious."

British Take German Wireless in Spitzbergen

SEIZURE by a British expedition of German mining property and other development plants in Spitzbergen, including a big wireless installation, is reported by the London Express. The coal and iron deposits will be of the greatest importance to Great Britain and the allies. The expedition sailed a few months ago under the protection of the British navy. Sir Ernest Shackleton, the Antarctic explorer, was the commander, but he was subsequently obliged to leave to take up other duties. His successor, F. W. S Jones, took a large number of miners, an enormous quantity of mining material and supplies sufficient for three years. Work is now going on on a large scale. Capt. Wild, who was with Shackleton in the Antarctic, is in charge of operations. Mr. Jones says the expedition met with considerable difficulties, including encounters with eight German submarines.

Believe Austria Has Secret Wireless Station

A Vienna message to the Frankfurter Zeitung states that the existence of a secret wireless installation is suspected at Prague, and the Austrian authorities are displaying considerable anxiety regarding it. Close search having failed to discover it, the installation is thought to be of a movable character.

Balloon Cable a Cross-Continent Aerial

THE wireless station at Arcadia, Cal., by using for aerial the cable of a balloon, put aloft from the training field, has intercepted messages sent by the Brooklyn Navy Yard wireless stations, according to an announcement by the War Department. This balloon cable probably makes the highest aerial in the world.

This announcement was made by the Division of Military Aeronautics, indicating increasing efficiency in both the work of students and the equipment of the War Department's various balloon training fields. The balloon school at Arcadia has 106 miles of wire in use in teaching military communication. For the purpose of demonstration it has a complete system of wiring strung as it would be in the front line trenches on the battlefield. Communication posts and stations for all kinds of messages are used by the students the same as soldiers use them at the front.

A good part of the country southeast and southwest of Arcadia is laid out with lines of communication to this balloon school, similar to part of a sector at the front. All of the balloons, when aloft, are so wired that they can be lined together with any trench, doubled up for any work together, or they can be cut off from the trenches and talk only with their own chart room and winch or operating crew on the ground below.

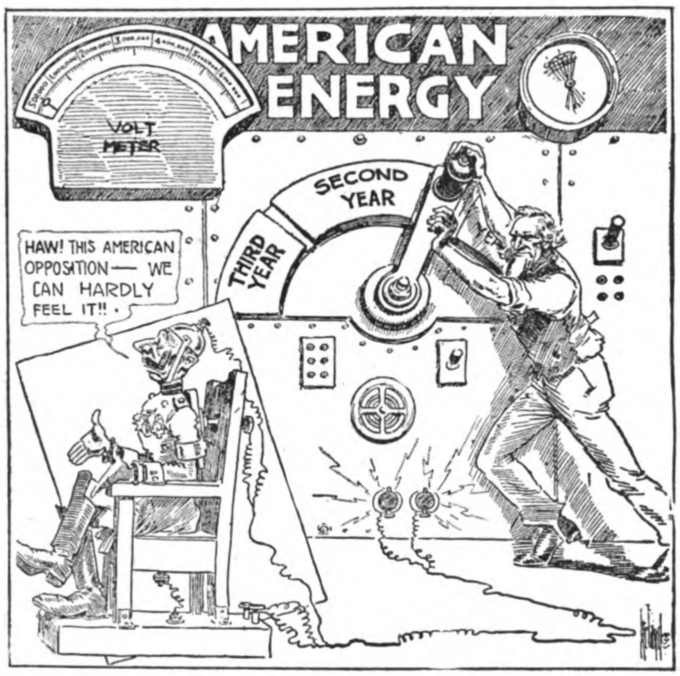
Isle of Pines Radio Resumed

THE Department of Commerce has received from the American Consul at Isle of Pines, Cuba, information that that island once more is in telegraphic communication with the world at large. A new wireless station has been constructed to replace the one destroyed by a hurricane at Nueva Gerona last September.

The new station is claimed to be far superior to the one destroyed and it is said to be the second largest in Cuba and to have a radius of 500 to 600 miles in the daytime and about 1,000 miles at night. The tower is 250 feet high and the cost of construction of the station is estimated at $20,000. Messages can be sent direct to the United States at night, via Arlington, Va., but may have to be sent via Havana, Cuba, in the daytime.

A Wireless Message Around the World

A FEW years ago the news that a wireless message had enveloped the globe would have been astonishing, would have been the news of the day, notes the N. Y. Times. News values have altered since August 1, 1914, and on October 2 the report of this event was printed briefly. News value is an expression which, being translated, means "what people are interested in," and in these days proportions are altered.



Ireland in the Columbus "Dispatch"
"Don't be impatient, Bill, you're going to feel it"

The short report printed was that direct communication between England and Australia, a distance of 12,000 miles, had been established. Twelve thousand miles is half way around the globe. But since the electromagnetic waves move equally in all directions, this message moved also in the opposite direction to that in which it was aimed and covered the other 12,000 miles. It did more than that, it enveloped the entire globe in every direction. Puck offered to spread a girdle around the world; this scientific Puck changes the girdle into a mantle.

That, however, is a feature of the report which only tickles the love of the marvelous. The practical side of it is not the encirclement of the globe, but the sending of the message to the intended receiver of it halfway around the circle. "The messages were received with perfect clearness." They went from the Marconi station at Carnarvon, Wales, to the Amalgamated Wireless Company of Australia at Sydney. The abounding achievements of science during the war, many of them directly caused by the war, are getting little attention compared to the bloody drama itself, but after the war they will come into their own.

American Marconi on Preferred List of Peace Stocks

STOCK of the Marconi Wireless Telegraph Company of America has recently shown marked activity in the New York Curb market. A leading specialist brokerage house is bidding 4⅛ for the holdings of its customers, stating that "among the so-called Peace Stocks, Marconi Wireless is on the preferred list." The statement issued adds that this is due to the general admission in commercial circles that the business of the company will expand enormously all over the world. The opinion continues that, when the war is over, Marconi Wireless of America must be regarded as one of the best and most profitable investments in the industrial group, and the steady accumulation of this stock, at a little below par ($5) a share, is for some of the best-posted authorities in Wall Street. who recognize that the outlook for Marconi is very bright.

It is intimated that the strength of the issue has partial foundation on the action of the company on August 1, when a dividend of 5 per cent. was paid, the belief being general that this dividend is the forerunner of regular annual or semi-annual dividend payments.

Naval Radio Men Score 100 Per Cent. on Loan

THE Eleventh Battalion at the Naval Radio School at Boston subscribed 100 per cent. to the Fourth Loan. The average subscription of each man was $61.22. As we go to press, $125,000 has been obtained at the school, the Eighth Company ranking second with 46 per cent. subscribed. Lieutenant W. D. Fleming, assistant paymaster, was in charge of the station's campaign.

France Completes Radio Chain With Giant Station

THE American Army will soon be sharing with the French in the operation of the highest and most powerful wireless sending station in the world. This is now nearing completion on the French coast—the point cannot be stated—and its giant towers can be seen rising 810 feet, or 300 feet higher than the Eiffel Tower. Soon it will be in direct touch with America, with far more power than ever before, supplementing the cable for transatlantic service and perhaps with its new power rivaling the cable for quick communication.

All along the front small wireless stations have been set up to intercept enemy radio exchanges and locate enemy stations. Messages are picked up from all the capitals of Europe, and especially from the larger German cities. This practice of intercepting messages seems to be universally accepted as a war necessity, and the crop daily gathered includes those from friends as well as foe. The enemy has many small radio stations along the front which are in constant communication with Berlin and Hanover, the two central enemy stations.

The American Army controls a quadruple cable line across the English Channel, which connects the French telegraph and telephone system directly with the English lines. Thus American officials are brought together for direct immediate exchange between Paris, London and American headquarters at the front.

The Signal Corps has undertaken a huge work with some 3 to 4 per cent. of the entire Army—or about 35,000 officers and men in a force of 1,000,000 men—maintaining the steady flow of communication throughout this nerve system of the American Army.

Periscopes and Wireless on Army Tanks

YANKEE ingenuity provided many surprises for the Germans in the St. Mihiel drive. Some of our tanks were equipped with periscopes, enabling the crews to look over the high ground in front of them.

The tanks attached to the American corps were constructed in France in accordance with American plans. All are manned by American crews. The machines are small, fast and powerful two-seaters, equipped with strong offensive armament.

Each carried a wireless outfit, and many a message was flashed from tanks to airplanes, which, in turn, were sent back to headquarters in the rear.

The heavier armor makes our tanks nearly proof against the German anti-tank rifles except for certain direct hits.

One American chauffeur showed the greatest skill in conducting his monster, stamping out the German machine-gun nests by reversing one caterpillar and putting full speed on the others, thus turning round and round till the enemy strongholds were crushed.

New Galena Discovery Cuts Price From $112 to 7 Cents Per Pound

THAT the unusual type of galena ore, used by the government in wireless receiving apparatus and formerly purchased from abroad at a cost of $7 per ounce, is found to some extent in two mines of Utah—the Tintic Standard and the Scranton, both of Tintic—is a fact that is leading to still further search for larger deposits of the much sought for metal.

Only a short time ago the government had the burden of the $7 per ounce price lifted by the discovery, made by S. M. Soupcoff, of Salt Lake, of a quantity of the ore in Smuggler mine, Aspen, Colo., which was purchased at the price of 7 cents per pound. The ore, about ten tons in volume, occurred in a big pocket and the government bought all there was. This will last probably a year, but not much longer, owing to the rapid growth of the wireless industry, and the search for another deposit equally as good is consequently kept up.

Captain E. J. Raddatz states that the desired ore, in small quantities, had been found in the Tintic Standard mine, but never in a quantity sufficient to make handling it worthy of consideration from a commercial standpoint. A similar ore has also been found in the Scranton, a shipping property of the Tintic district. This, too was only in small quantities.

The ore required in the making of detectors for wireless is the purest galena that can be found, 86 per cent lead.

Enemy Aliens Barred From Jersey Coast

UNDER a Presidential order issued October 2, practically the entire territory from Rockaway to Point Pleasant, N. J., along the ocean front and for a distance averaging three miles or more back is made a zone barred to German aliens except under permit.

Rockaway Point, all of Staten Island and all of the New Jersey shore resorts come within the restrictions of the order, which was issued as a means of shutting off all possible communication between the shore and submarines operating at sea.

It is estimated by the Federal authorities that approximately 15,000 Germans are affected.

The order provides that "no German alien enemy shall reside in or continue to reside in, remain in or enter any of the areas so prescribed, except by permit of the President and under such limitations or restrictions as the President may prescribe."

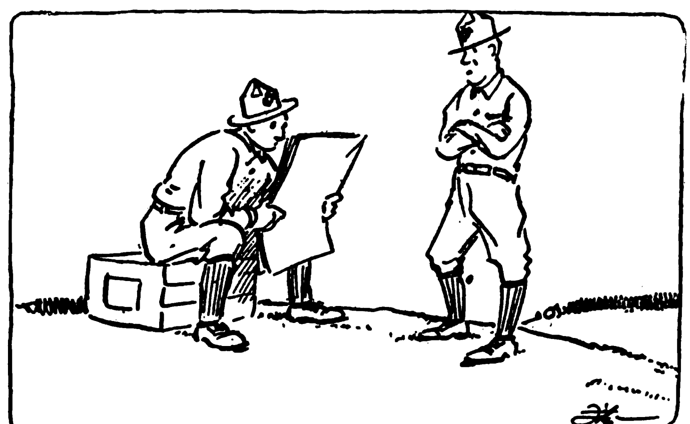
Where it is deemed advisable permits will be issued by United States Marshals of the affected zones, with the approval of the United States Attorneys or the Alien Enemy Bureau of the Port of New York.

Since submarines first made their appearance on this side of the Atlantic, reports have come persistently to the officials of the Army and Navy Intelligence of lights flashing from the shore and the operation of secret wireless stations. The Highlands of Navesink and the high points on Staten Island have been repeatedly subjected to investigation, as have other points further south on the Jersey Coast.

In one case a small dismantled wireless apparatus was found in the possession of a German. While proof has never been obtained of actual communications sent to sea, it was decided that the only safe way was to bar Germans from all points of vantage.

German Wireless Officer Arrested in Rochester

THE Intelligence Department of the Army made a great catch when its agents landed Lieut. Ernest Adolph Buderus von Carlhausen in Rochester, N. Y., on February 16 last, after trailing him from New York. Some of the facts concerning this man's activities have been given out by the Rochester office of the Department of Justice.



Fitzpatrick in St. Louis Post-Dispatch

"This paper says Hindenburg is dead"
"Which one of the marines got him?"

The marines in France have lived up to the best traditions of valor in the service. The boys in Fitz's cartoon naturally conclude that their mates, if anybody, would have "got him"

The German, it appears, is a wireless expert, and while in Rochester attempted to purchase a tract of land on Irondequoit Bay, in a secluded location, with the intention of erecting thereon a powerful wireless plant from which messages might have been sent direct to Germany.

Carlhausen was employed at the Ritter Dental Manufacturing Company while in Rochester, and lived with a woman not his wife, according to information in the hands of the authorities. His wife was arrested shortly after Carlhausen himself was captured, the woman being found on Long Island. She is said to have made a record before the war as a diplomatic spy, and is believed to have succeeded in getting valuable papers into the hands of German agents. The theft of a code book of an American battleship was one of her most important coups. A naval officer was court-martialed for this.

Carlhausen was also receiving mail as Ernest A. Buderus. He is a graduuate of the naval college at Kiel, and is an electrical expert.

The German is now interned at Fort Oglethorpe, Ga.

Radio Frequency Changers

Reported Progress in Their Application to Wireless Telegraphic and Telephonic Communication

By E. E. Bucher

Director of Instruction, Marconi Institute

STUDENTS of radio telegraphy are familiar with use of frequency-multiplying transformers for increasing the frequency of a normally low-speed radio frequency alternator to a value suitable for transmission at commercial wave lengths. This system has not been widely adopted, in fact, prior to the war it had been employed in but one instance in the United State, viz., at the Telefunken Station, Sayville, L. I.

It is claimed by the inventors that this method of multiplying frequencies possesses certain inherent advantages over the radio frequency alternators of either the Alexanderson or the Goldschmidt reflector types,

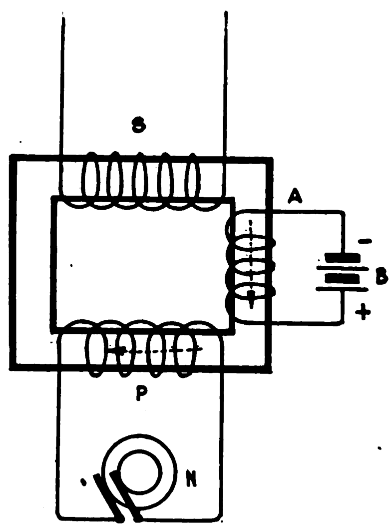


Figure 1—Diagram showing the fundamental principle of the frequency changer

chief among them being the reduced initial expense of construction. In order to secure large power outputs from either of these machines a very expensive design is required. The high peripheral velocity of the rotor is another factor difficult to get around except at the lower frequencies.

In the frequency transforming system the alternator frequency lies between 5,000 and 15,000 cycles per second, which partially reduces the mechanical and electrical problems, particularly at frequencies exceeding, say, 75,000 cycles. Secondly, the length of the wave motion radiated by a radio frequency alternator is not readily changed, for it requires a change of armature speed and a consequent readjustment of the tuning circuits for electrical resonance with the aerial, the readjustments being more complicated with the Goldschmidt machine than with the Alexanderson alternator. Furthermore, the maximum output of the radio frequency dynamo is secured at some constant speed, which if changed to another speed to give another frequency, results in uneconomical operation. Other difficulties arise in the control of the antenna currents from such alternators for radio telegraphic and telephonic signaling. On the other hand, the frequency of the antenna currents in the frequency transformer system can be quite readily changed by the aid of special circuits here to be described. The iron and eddy current losses in the frequency transformer system, however, must be considerable, as is evidenced by the fact that oil and water cooling facilities are provided. Just what commercial application these frequency changers will have in the future is difficult to state, for we are required to rely on the statements of the inventors, solely, as regards their efficiency.

The fundamental principle of the multiplying frequency transformer system may be partially explained by aid of the diagram, figure 1, where P and S are the primary and secondary coils, respectively, of a radio frequency iron-core transformer, fed by, say, 10,000 cycles from an alternator N. A DC excitation

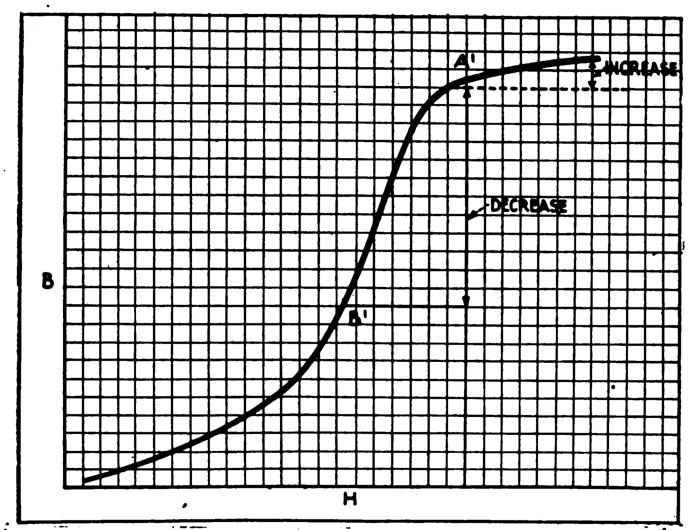


Figure 2—Characteristic B-H curve

winding A, fed by a battery or dynamo B brings the magnetism of the core to the "knee" of the characteristic saturation curve or to the point where an increase of current results in practically no increase in the magnetism.

Such a curve is shown in figure 2. This is commonly called the B-H curve where H represents the ampere turns of winding A and B the resulting magnetic flux through the core. Point A′ is the "knee" of the curve.

Now in the circuit of figure 1 there is superposed on the flux set up by winding A, the flux induced in the coil by winding P (fed by the alternator) and when P sends its flux in the same general direction of that set up by winding A, it is evident from the curve that the total flux is but slightly increased. The resulting wave of magnetization is flat-topped and it, therefore, has practically no effect on the secondary winding S.

On the other hand, the reverse cycle from N opposes the flux from A, resulting in a considerable decrease, say to the point B′ (on the curve) and the wave of magnetization becomes peaked, that is, there is a large decrease in magnetism through the core, which on the termination of the half cycle of current from P, returns to the normal value of magnetization.

This decrease and subsequent increase of the magnetism through the core induces two pulses of current in opposite directions through S; in other words, a **complete cycle of alternating current.** In summary,

the first half-cycle from P has no effect on S and the second half cycle induces a complete cycle of current in S.

A transformer of the type described would have

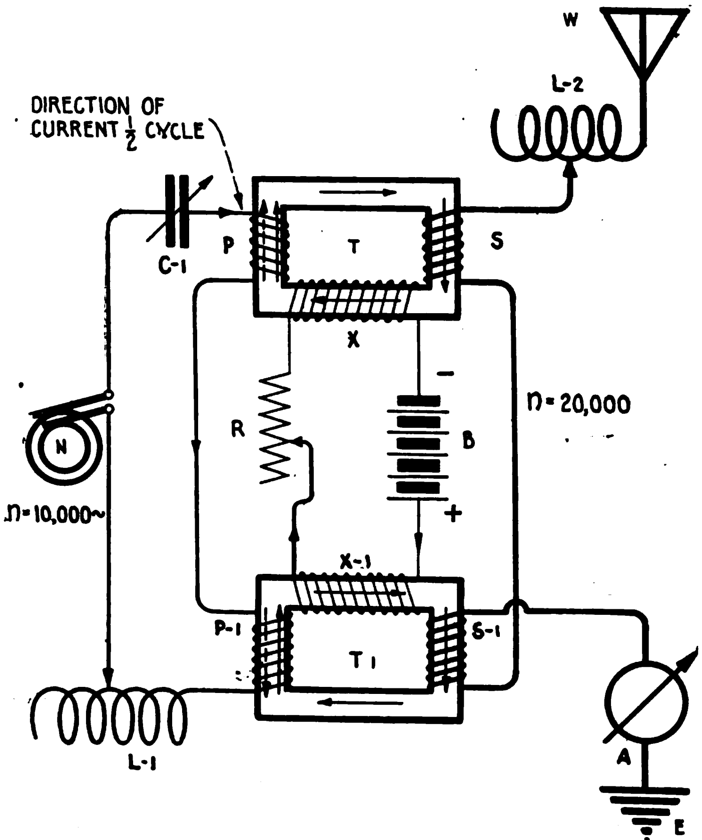


Figure 3—Circuit employing two transformers to produce current of double frequency

no practical value for only ½ cycle of the alternating current is employed, in other words, a DC pulsating current through P in the proper direction would have the same effect. However, if two transformers are employed, as in figure 3, both alternations of the complete cycle from the radio frequency alternator are utilized so that current of double frequency flows in the complete circuit of S.

In the system shown in figure 3 the frequency of the 10,000 cycle alternator N is increased to 20,000 cycles in the antenna circuit corresponding to a wave length of 15,000 meters. T and T-1 are closed core transformers suitably designed for radio frequency currents. Primaries P and P-1 are wound in relative opposition. Secondaries S and S-1 are wound in the same direction. The transformers are saturated to the knee of the characteristic curve by windings X and X-1, which are also in relative opposition. B is a source of direct current, either a storage battery or DC dynamo, and R a regulating resistance. Choke coils (not shown) are connected in series with the DC leads to prevent the induction of radio frequency currents in the exciting circuit. One terminal of the winding S and one terminal of the winding S-1 are connected to the aerial and earth, respectively.

The circuit of the radio frequency alternator N is completed through the variable condenser C-1, primary windings P and P-1, through coil L-1. C-1 and L-1 tune the complete primary circuit to the frequency of the alternator.

Assume that the fluxes in the cores have the direction shown by the full line arrows, and moreover, for a half-cycle from the alternator the direction of the current is as indicated: the flux generated by winding P then has the same direction as the flux in the core of transformer T, and as a consequence, no induction takes place in S; but on the other hand, the flux generated in P-1 opposes the flux in the core of T-1, causing a complete reduction of flux and a subsequent rise to normal saturation. The result is the induction of a complete cycle of current in the winding S-1 for ½ cycle through P-1. For the next half cycle the process mentioned takes place in secondary coil of transformer T. Therefore, there will flow in the antenna circuit two cycles of current for each cycle through P and P-1; in other words, the frequency is doubled. Resonance as usual is established by the aerial tuning inductance L-2, and maximum antenna current is observed by the aerial ammeter A.

It is obvious that by an additional set of transformers connected to the terminals of S and S-1, the current of double frequency may again be doubled, but the efficiency of the apparatus decreases as the steps of transformation increase. A complete system for increasing the frequency by three steps is shown in figure 4.

The phenomena involved in the induction of currents in the circuit of figure 3 can be explained graphically by the series of curves in figure 3-A where graph O-1 represents the alternating current supplied by the radio frequency alternator N. In graph O-2, the dotted line represents the normal flux through the iron-cores set up by the DC excitation windings. The flat-topped portion of the curve B indicates the state of magnetism when the fluxes of the primary and excitation windings add up. On the other hand, the peaked portion of the graph shows the change of flux when the two fluxes in the core are in opposition.

The graph C shows the change of magnetization in the second transformer; it is to be noted that the peaks of B and C are separated by ½ cycle. The in-

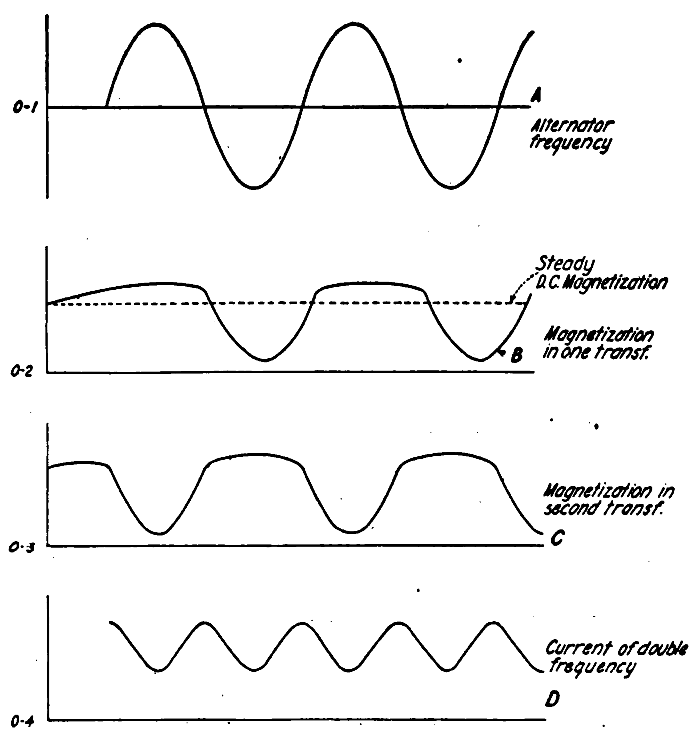


Figure 3A—Series of curves showing graphically the phenomena involved in the induction of currents by circuit in figure 3

duction due to these peaks of magnetization is shown in graph D which is seen to be of double frequency.

Regarding the Design of the Frequency Transformers

Each transformer in a frequency changing group comprises an annular or rectangular closed arm yoke composed of thin laminated iron sheets so constructed

that each sheet is seamless and has the form of the complete yoke. The thickness of the sheet decreases with increase of frequency.

The variation of flux generated by the alternator has a tendency to induce high voltages in the excitation windings fed by the DC dynamo, and in order to reduce these E. M. F.s to a safe value, it is of advantage in high power sets to divide the excitation coils into groups A, B, C, connected in parallel as shown in figure 5. A low voltage DC generator is then employed. If several frequency changers are used a single DC generator may be employed to excite all the windings.

It is found that the greatest efficiency is secured from these frequency changers when the effective number of ampere turns for the radio frequency winding is approximately equal to the ampere turns of the DC winding. The former should not exceed the latter by more than 20%. It tends toward increase of efficiency also to keep the magnetic leakage of the transformers at a minimum. The iron and copper

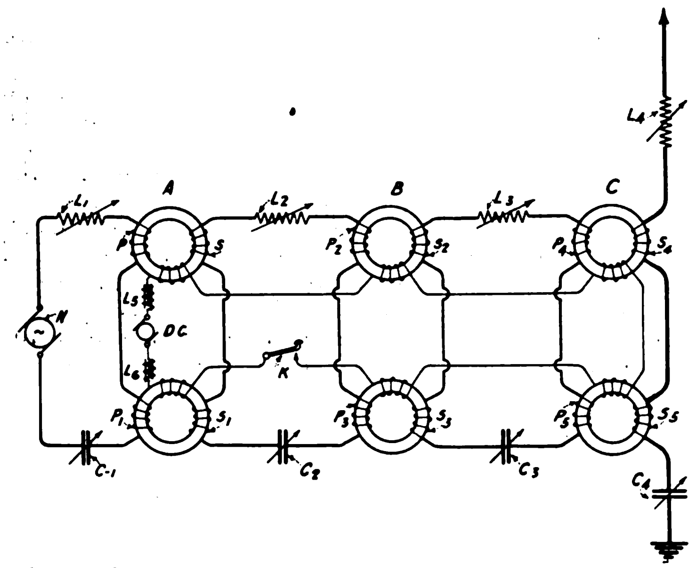


Figure 4—System for tripling the frequency of a radio frequency alternator

losses must be reduced to the lowest possible value. The windings must be uniformly placed over the length of the yokes. In case very large power outputs are required the closed iron yokes should be constructed of individual insulated packs of sheet metal with intervening air spaces. The windings should also be arranged to give air space between the individual layers. The entire apparatus should then be submerged in oil circulated between the windings and the packs of sheet metals.

Three Step Multiplier

In the diagram of figure 4 the frequency of the alternator N is doubled by group A, doubled again by the group B and doubled once more by the group C; therefore if the frequency of N = 10,000 cycles per second, the frequency of the current in the antenna circuit will be 80,000 cycles, corresponding to the wave length of 3,750 meters Resonance in the antenna circuit is then established by the aerial inductances L-4 and, variable condenser C-4. It is to be observed that a single DC generator excites the cores of groups A, B and C, and that signaling is accomplished by opening and closing the key K. The circuit between groups A and B is tuned by inductance L-2 and condenser C-2; and the circuit between groups B and C by the inductance L-3 and the condenser C-3. Careful adjustments must be made in this circuit for maximum efficiency.

Redoubling Transformer System

Von Arco and Meissner have recently shown modifications of figure 3, the objects of their design being to still further multiply the frequency, to modulate the antenna circuits at speech frequency for telephony,

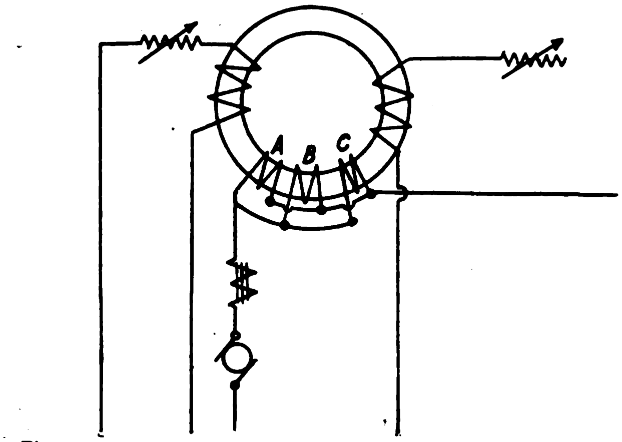


Figure 5—Showing method of reducing the production of high voltages in the excitation coils

or to permit telegraphic signaling Special designs are offered to eliminate the induction of excessive high voltages in the various circuits. In fact, the inventors have encountered problems in the frequency transformer system equally as severe as other investigators have in respect to the high-speed radio frequency alternator, but step by step they have described various means for eliminating undesirable phenomena in the operation of the system.

A modified circuit in which the increase in frequency is obtained by superimposing the current from the secondary coils of a subsequent step upon the coils on a preceding step, is shown in figure 6. Through group A and group B there is induced in the coils S-4 and S-5 a frequency of four times the initial frequency, which is fed back through the conductor D, variable condenser C-1 and the inductance L-1 to the primary coils P and P-1 of the first step. This current is again doubled to eight times the initial frequency by group A and to sixteen times the initial frequency by the group B, the latter current flowing in the antenna cir-

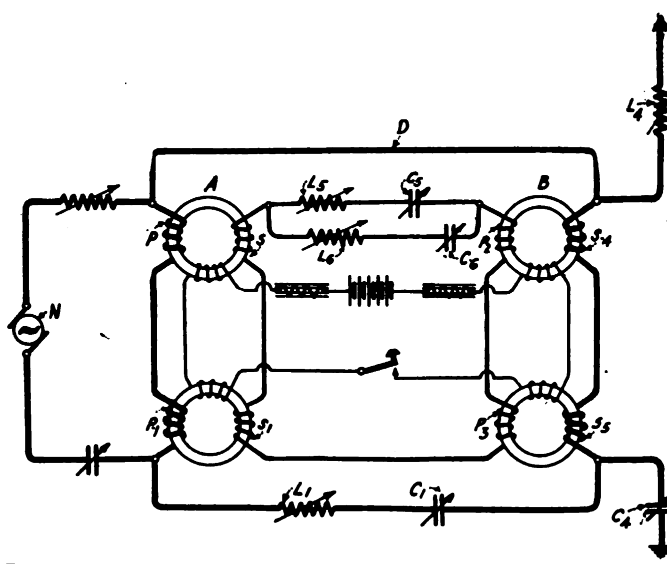


Figure 6—System for redoubling the frequency by superimposing the current of the last step upon the first step

cuit which has been carefully tuned to this frequency by the inductance L-4 and the condenser C-4. If the frequency of the alternator N is 10,000 cycles per second, the frequency of the antenna oscillation will

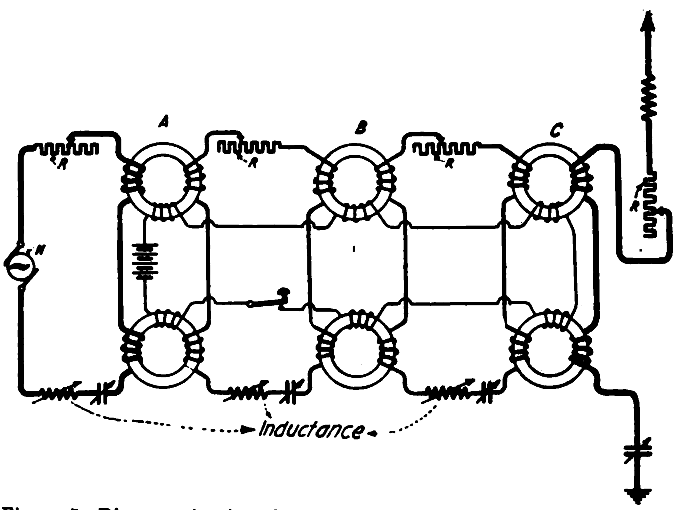


Figure 7—Diagram showing simple method of tuning the radio frequency changers

be 160,000 cycles per second, corresponding to the wave length of 1,875 meters. This brings the radiated wave down to a value suitable for transmission on the larger classes of vessels where large aerials can be erected.

It is evident that several paths must be provided for the currents induced in S and S-1 and that they must be carefully tuned to the various frequencies. Thus, inductance L-5 and condenser C-5 provide a path and act as tuning elements for the current of twice the fundamental frequency, and L-6, C-6 a path for the current of eight times the fundamental frequency. In all other respects the circuit is identical with figure 4.

Aperiodic Frequency Multipliers

Von Arco and Meissner have found through practical experience that the procedure of tuning the several circuits of cascade frequency multiplying systems such as shown in figures 4 and 5 becomes exceedingly tedious, for these circuits must be tuned to the impressed frequency of the alternator and any slight change in the frequency of the alternator will require a total readjustment of the circuits. The range of resonance is small and due to the extremely tight coupling between the various transformers, inductive disturbances arise which make it difficult to locate the resonance adjustment quickly. Again it is desirable in many stations to provide apparatus permitting the wave length to be quickly changed, but obviously if the transformer system has a multiplicity of tuning elements, it offers too many complications to permit this to be done quickly.

Two solutions of the problem have been given by the inventors whereby the problem of tuning becomes relatively simple. The circuits are shown diagrammatically in figure 7 and figure 8. In figure 7 adjustable resistances R have been placed in the generator, intermediate and antenna circuits to increase the damping. During the first adjustments to resonance, they are thrown in the circuit at full value and as the inductance and capacity are changed for resonance (as will be observed from the reading of the aerial ammeter), the resistances are gradually reduced until the maximum efficiency of conversion is secured. The foregoing process greatly assists the preliminary adjustments of the apparatus at any particular wave length, the circuit being first tuned roughly and finally more sharply.

In the system shown in figure 8 the tuning of all steps is eliminated except that of the antenna circuit, the intermediate circuit being adjusted for very high damping not by the insertion of resistance coils as in figure 7 but by giving the various windings a greater number of ampere turns so as to increase the damping. In the diagram A and B are two frequency transformers with the usual intermediate circuit, S-1, P-2, S-2 and P-3 and the excitation or magnetizing windings L. The antenna circuit is connected to the last set through the transformer M-1 with the adjustable secondary.

Owing to the high damping provided by these windings they act like ordinary transformers in which the phenomenon of resonance is not so evident. The resistance of the windings is comparatively large as is the self-inductance. The capacity of the condensers C, C-1 and C-2 is also very large to assist materially the damping factor.

Transformer M-2 is wound with a large number of turns to make the circuit of the generator nearly at aperiodic. The adjustable secondary of the transformer M-1 permits the E. M. F. in the antenna circuit to be adjusted to a safe value. If the frequency changer secondaries were supplied with variable secondary windings, the same results would be secured.

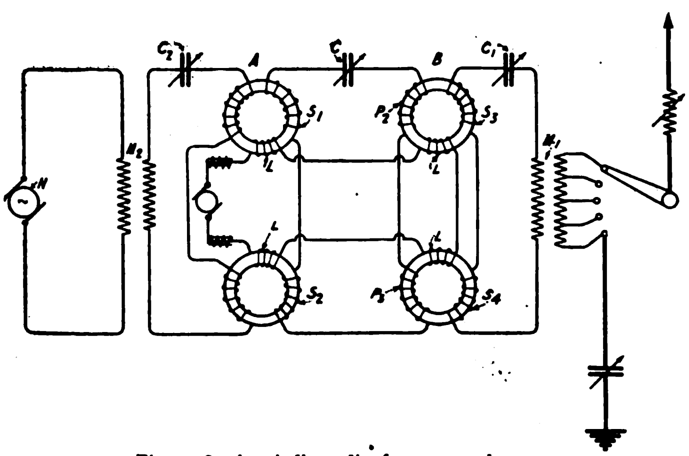
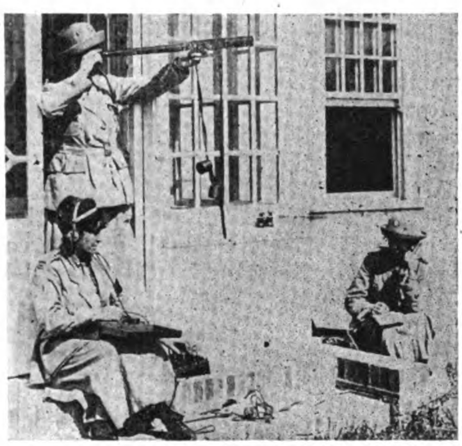


Figure 8—Aperiodic radio frequency changers

The inventors remark that the efficiency of conversion of this type of apparatus is comparatively good and at high powers the loss of energy due to the lack of resonance is negligible considered from a commercial view-point.

(To be continued)

When "Bunty Pulls the Strings" in a position back of the British lines a highly destructive shell screams over No Man's Land to return the Hate of Fritz. The photo on the left shows Bunty, a favored high calibered cannon of our Allied artillery



Above, in circle, are the chiefs of the headquarters Aviation Section with the American forces in Great Britain. Seated, Col. C. R. Day; standing, left to right, Lt. Col. W. H. Harms, Major W. A. Larned, Major W. H. Shutan

At the left, members of the Women's Signal Corps, composed of prominent Englishwomen, training in field buzzer and telephone communication

Mobility of equipment is equally as important as troop transport, so the caterpillar tractor goes forward on a speedier motor truck

Press Ill. Svce.

An actual scene on the first line with the battle raging across No-Man's Land. This is the view that the Signal Corps man gets as he maintains the lines of communication in the trenches

Under Fire With the Signal Corps

WHEN the average man hears the Signal Corps mentioned he has a somewhat hazy idea of its work and of how it is connected with the vast organization of the modern war machine. Even to the man in the army the Signal Corps is more or less an unknown quantity.

The activities of the Signal Corps are so wide in scope and their development of so recent a date that this vagueness is not to be wondered at. Until the time of the Civil War, armies and their units had been small enough to permit the commander to keep sufficiently in touch with his forces by runners and mounted messengers. During the Civil War, however, armies grew so large and unwieldy that their efficiency began to be impaired through lack of a perfect system of communication. It was seen that no matter how perfectly trained an army might be in its various activities, if it was unable to know the proper time to perform, its efficiency was imperilled. In fact, it was already realized that a perfect army is nothing more than a perfect soldier on a vast scale and, like that soldier, in order to be of any service or accomplish its aims, it must have a nerve and control system just as perfect as his.

The first step in improving the signal service was the use of the telegraph which, at the time of the Civil War, had been commercially perfected. While some progress was made at that time in its use, it was not until the time of the Spanish-American War that the signal service of the army was employed on anything like the scale of today. During that war the Signal Corps was an entirely mounted organization and was required not only to be as mobile as the cavalry but was even required to anticipate the needs of the cavalry and immediately have stations, where all officers could transmit messages, open and working as soon as the cavalry came to a halt. Our Signal Corps had developed a system of communication for open warfare that was practically perfect; in fact one which would have given any number of pointers to even the perfect German war machines.

At the opening of the present world war it was seen that the signal service as organized for open warfare would not be applicable to the different conditions required in trench warfare. As our entry into the war seemed so remote there was nothing done actually to change our methods, but at the same time the Signal Corps was making a study of the various means of communication in use by the different armies in Europe.

As soon as war was declared it was known at once just what the duties of the Signal Corps would be during the several months before the actual entry of our troops upon the firing line. It was known that the moment our force set foot on foreign soil to study and determine the method of warfare to be adopted it would be necessary to keep this force in constant communication with the authorities at Washington. As soon as it was decided that our operations would be in France the material and the personnel for laying trunk telephone and telegraph lines from the various seaports through the heart of France over to the theatre of operations were at once assembled, and this personnel was among the first actual troops to be sent over. Today there is scarcely a city in the principal part of France through which an American telephone line does not pass.

As soon as it was decided that we were to adopt the French methods of warfare we began to make a study of the French system of signaling. While we speak of having adopted the French system of warfare, this is

The Marines, too, have their signal units; here they are shown grouped above a telephone switchboard used at division headquarters

only approximately true as concerns the work of the Signal Corps. The main problems were to see what different kinds of messages had to be transmitted, the various ways the French had of doing it, whether any of the English methods were an improvement, and, lastly, whether we could not work out a system combining all the merits of the others, at the same time omitting their defects. This has been done so far as possible, and the United States Signal Corps now has a system of signaling as applied to trench and semi-open warfare which represents the most modern ideas of all the armies now at war, including even the German.

The success of this system is attested not only by the way in which it works in trench warfare but even more forcibly by the manner in which it has enabled perfect communication to be maintained in the first big offensive of the Americans.

In the dugout the quick-witted signalman is a valuable aid to the guns which are firing overhead

The lines of information from the various army headquarters are continued practically in the same manner as the main trunk lines that run through France in the service of supplies. Radio begins to play an important part in the game. However, it is within the division itself that the development of all means of communication takes place. Here every method of signaling that has ever stood up under the ordeal of battle plays its part. The whole area within ten miles of the front line is a maze of "lines of information." For convenience these lines may be divided into four great net works, any one of which may be depended upon as a complete and independent means of transmitting information.

The first and most complicated is the wire net. This begins at division headquarters and reaches its tentacles out toward the front in all directions. Its large central telephone exchanges located at intervals over the entire front, sometimes in half-demolished dwellings, sometimes in dugouts 40 to 50 feet deep, are the busiest spots on the battlefield. Its lines must furnish communication for the artillery, machine guns, the infantry, the trench mortars, the balloons, the engineers, the field hospitals, and all the other units that go to make up the war machine. In fact, the telephone system is much more elaborate and more complicated than in a young American city.

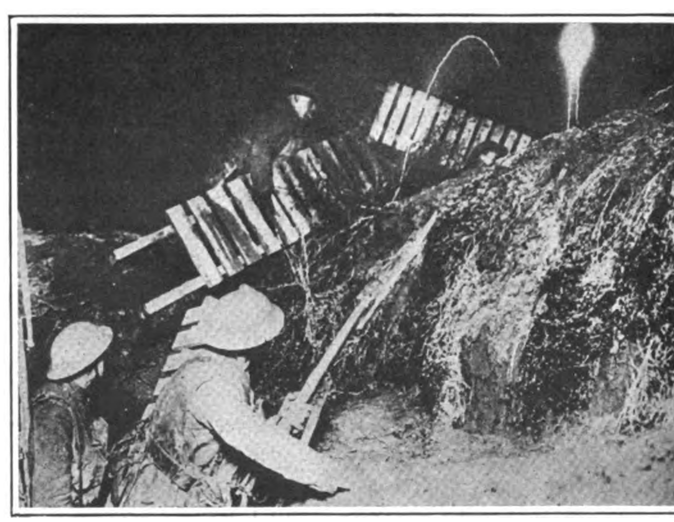
The problem of laying the wires under shellfire and keeping them in repair at all times is enormous. While the Field Signal Battalion of the Signal Corps is directly in charge of all systems of communication within the division it is assisted by telephone men from all the other units who work under it and carry out its ideas. The wires are often in the form of large buried lead cables, for whose installation it is necessary to employ highly specialized cable splicers, who carry on their work often with shrapnel raining around them. Lines radiate from these cables in smaller trunk lines, all of which have to be buried, but as these lines approach the front they are laid along the sides of the trenches the soldiers use.

It would be necessary to bury cables or wires fifteen to twenty feet to make them at all immune from shellfire, and as it is almost impossible to accomplish this, it can be seen how great are the troubles which the signal men encounter in trying to locate and repair breaks, especially in rain and snow or on dark nights, when the mere lighting of a match would be a welcome target for the enemy. All the wires have to be so carefully tagged and labeled that the telephone men can creep along a wire and merely by feeling these labels know exactly from what point the wire starts and where it terminates.

Another system which works independently of the wire system and which will interest the man who is inclined to wireless rather than wire work, is the radio net, which in itself furnishes complete lines of information throughout the area. In this net are employed radio instruments such as the average American radio man never dreamed of. Beginning at the front line are little radio sets with antennae so small that they can easily be concealed in a dugout. A little further back are trench radio sets whose transmitting range is larger than those in the dugouts, but whose antennae are so small that they can be placed just off the ground and not be seen by the enemy, or can even be placed in an unused communication trench.

The radio serves a great mission in the artillery, where it is relied upon as the fundamental means of communication between the artillery and the airplanes which see and control the fire of its guns. Each shot is observed by one or more airplanes, which at once send with their radio sending sets the exact information of the result of the shot to the radio receiving set back by the guns. In this way it is possible accurately to adjust the fire of the guns on a target, which without the use of the radio

(*Continued on page* 36)



When an advance is made the signalman goes over the top, too, for laying wires under shellfire is a routine part of his job

Code Practice for Receiving

The Principle, the Four Stages, and the Basic Law

By Gordon Lathrop

Of the Marconi Institute

IN last month's article the writer specified four stages of code sending, through which the code student must pass before he becomes expert in transmitting messages.

Phrased a little differently, though fundamentally identical, four stages may be defined through which the receiver must pass.

The first stage in sending finds the aspirant learning to construct each letter, numeral and punctuation mark in proper form.

The first stage in receiving is when the beginner is learning to detect, and write down, each letter, numeral, and the punctuation marks of common usage—to detect each, moreover, as a sound, an individual cadence.

The second stage in receiving is like the second stage in sending. This stage in sending has already been described as: "Learning to make a succession of letters to compose a dictionary word, code word or cipher combination in rhythmic steadiness." Applied to receiving, the second stage would be: Learning to detect and write down, accurately, and with comprehension of the word in its entirety, a succession of letters to compose a dictionary word, code word or cipher combination.

It is not enough to write down the letters blindly. Connection of the letters in word form should be made. That part of the brain which has to do with the registration of the cadence of each letter should be co-ordinating with those faculties which consciously recognize the word in its entirety.

Short, commonly used words, arranged in alphabetical relation, should be sent the beginner of this stage. Greater speed of transmission of words of increasing length may be gradually applied. Code words and cipher combinations may be included as part of the practice during this stage.

Building Up Endurance

The third stage in receiving, as is the third stage in sending, is that period during which the student is building up telegraphic endurance, so that he can last throughout the sustained periods which practical telegraphy calls for. Sentence practice should be added to word practice in this stage. Practice, practice, practice, aiming for accuracy and "clean" copy, rather than for speed, is the prescription for this stage.

The fourth stage in sending is when the aspirant puts on his sending the final touches which produce style and speed. In receiving, this stage finds the code man learning, in general, the tricks of the speedy telegrapher. Specifically, his aim should be to learn the forms of telegraphic communication which prevail in the particular branch of the art in which he desires to become a worker. Knowledge of the methods and forms, and of the phraseology employed in each of the branches of the telegraph field is essential to become an "all-round" expert telegrapher. Press, broker, commercial, railroad; radio in its increasingly numerous military and civil sub-divisions—each of these has its bag of tricks to be learned. Not until these become familiar can the telegrapher work at high speed in any particular branch.

Roughly, then, the four stages, in both receiving and sending, may be defined as (1)—The "A.B.C." stage; (2)—The word stage; (3)—The stage which makes for endurance, and (4)—The finishing-touches stage.

It should be noted that these four stages run into one another and are of indefinite lengths. What one student may acquire in telegraphic facility in one month may take another three months. Every telegrapher, however, must go through these four stages. Every one does, in fact, whether consciously or unconsciously; whether in proper sequence or haphazardly.

The Basic Law of Progress

A single principle rules throughout the four stages noted in the foregoing. The principle applies to receiving as well as sending, though perhaps not so obviously. It is self evident to even the novice in the code that the correct principle of sending is to keep the members which have to do with the process—the hand, wrist and forearm—in constant balance.

Even in such a physical process as sending, however, the hand, wrist and forearm will not keep in balance if the mind is not in harmony with telegraphic laws of progress.

"Progress in the order indicated by Stages 1, 2, 3 and 4," is the writer's conception of the basic law of correct progress in the code. "Do not pass from one stage to another until each has been thoroughly mastered in proper sequence," is its inevitably corollary. If an over-zealous student tries to whip an untrained hand and wrist into a speed which his desire wills, his sending will reflect the mental fault. He is out of balance, telegraphically.

The earnest endeavor of the student should be to resist the temptation to leap from one stage to another before he has thoroughly mastered each one in proper sequence. The practice of the code is peculiar in that one may experiment—after a fashion—and one is continually tempted to do it. The last stages of the art beckon invitingly to the novice immediately after he has learned the alphabet. But the student who tries for speed in sending before he has learned steadiness, is endangering materially his chances of ever becoming either a steady or a speedy sender. And he is not progressing. Time spent in trying to receive press matter, for instance, before he has learned to copy a succession of five-letter dictionary words with comprehension, is wasted.

The Acquisition of Balance

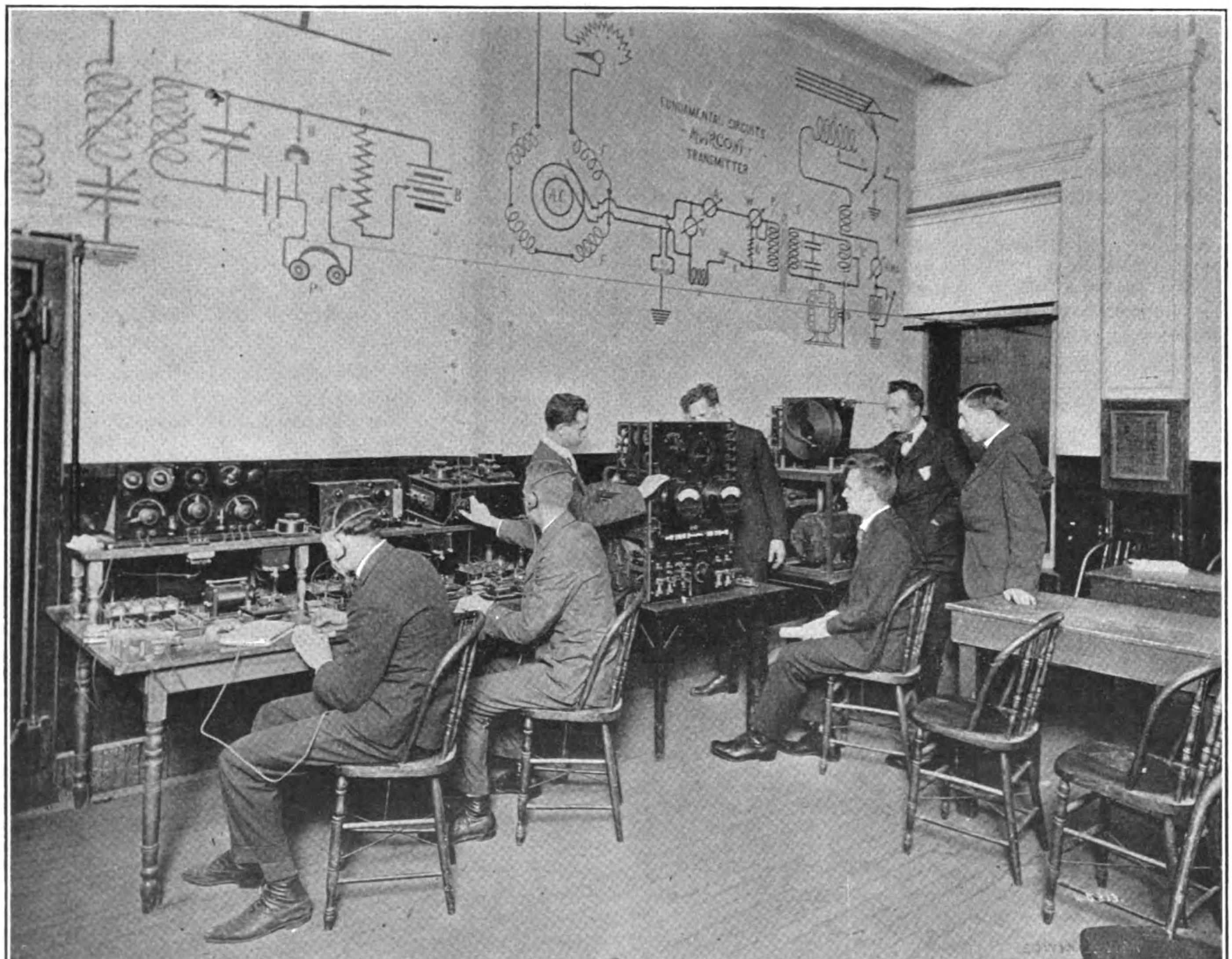
In applying to the receiving process the principle which is expressed in the one word "balance," the writer conceives the working of the mental apparatus in the same manner he would of a system of telegraphic machinery in proper relation and coordination. As a matter of fact, "in balance" is the term applied by technical men to such frictionless interworking of the telegraphic system. The whole will not balance if a part has been neglected. Moreover, the assembling of the apparatus must be done systematically.

The sequence of instruction given the beginner in telegraph receiving should likewise be systematic. Receiving is a process of taking on one conception after another; then of tucking them away—through the effort made by practice—in that part of the mind where are stored the things one knows so well they function without conscious effort. Not until the ideas of any particular stage function without conscious effort is the receiver "in balance" at that particular stage. The test of the student's right to progress from one stage to another should be whether he has learned to fulfill the requirements of each stage with a minimum of conscious effort.

In the first stage, there must be the correct conception of the letters "A" to "Z," for instance. Throughout all the intermediate stages, to the point where the radio man can detect cipher combinations through heavy interference, or to the point where the speedy press telegrapher, working with Phillips Code, will associate, for example, the letters "az," as sent, with the word "applause," the process of receiving is one of taking on and tucking away a sequence of correct conceptions.

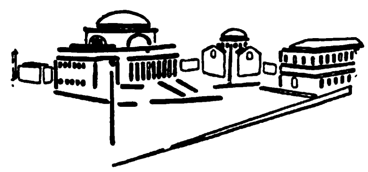
The duty of the code instructor, as the writer sees it, is to render the student's progress as free as possible of needless handicaps. Further, the instructor should lay out a system of practice material. It is the writer's opinion, based upon experience and demonstration, that this system should be built around the principle laid down in the foregoing; governed by the law of the code as stated, and its corollary, and arranged in recognition of the four stages of progress which have been specified.

In next month's article the writer will present an arrangement of exercises which he believes will help the beginning telegrapher as much as any prepared system can help. Primarily, in code as in everything else. the burden of achievement rests upon the individual.



Instruction in the adjustment of wireless receiving apparatus is given in the Marconi Institute during the period in which the students are perfecting their skill in receiving the code messages. In the photograph above members of an advanced group are shown operating various types of receiving apparatus, the nature of war service in which they will soon engage requiring familiarity with marine sets of varying powers from battleship equipment to submarine and Signal Corps apparatus for land and airplane use.

Progress In Radio Science



Marconi's Improved Radio Transmitter

READERS of THE WIRELESS AGE are already familiar with the apparatus developed by G. Marconi for the production of continuous oscillations by over-lapping wave trains. This system has proved most effective for long distance communication at high power. It has done away with many of the intricate mechanical and electrical problems encountered in the construction of radio frequency alternators or arc transmitter system. Moreover it makes an apparatus capable of generating damped oscillation at any spark frequency desired.

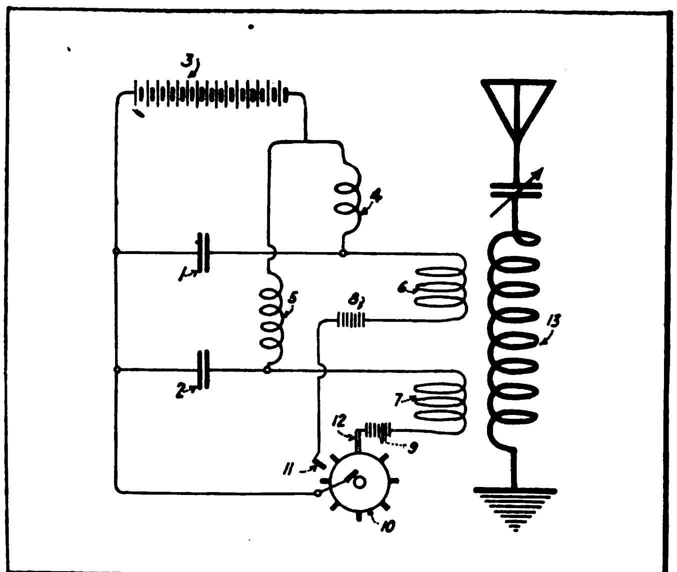


Figure 1—Circuit showing improved method of producing continuous oscillations by overlapping wave trains

In this system a number of spark discharges are made to occur successively in such a way, that the resulting trains of oscillations induced in the antenna circuit, overlap in synchronism. This results in the flow in the aerial circuit of oscillations of constant amplitude.

Numerous circuits have been devised by Marconi to carry out this fundamental idea, among which those shown in figures 1, 2 and 3 stand out prominently. The apparatus shown in figures 2 and 3 are modifications of figure 1.

In these diagrams, 1 and 2 are two high voltage condensers which are charged from the same source of current 3 (usually a direct current dynamo or a large storage battery), to inductance 4 and 5 respectively. These condensers discharge through primary coils 6, 7, the quenching spark discharges 8 and 9 and a disc discharger 10.

The electrodes 11 and 12 belonging to the condenser circuits 1, 6, 8 and 2, 7, 9 respectively are so arranged that discharges take place from 11 and 12 to the disc studs alternately at regular intervals and the interval between the commencement of the discharge of one condenser and the commencement of the discharge of the next condenser should be equal to or an exact multiple of the period of the aerial and intermediate closed circuit assuming that 6 and 7 are wound in the same way; if, however, they are wound in the opposite way, the interval should be equal to or an odd multiple of the half period. The primary coils 6 and 7 are coupled to a common secondary 13 which forms part of an aerial circuit.

The inductances 4, 5 should be large compared with inductances of the other parts of the circuits, but should, of course, not be so large as to prevent the condensers being sufficiently charged in the time available.

Figure 2 shows a modification in which a single inductance 14 through which both condensers discharge is employed, instead of the two separate inductances 6 and 7. This inductance is not coupled directly to the aerial but to an intermediate oscillating circuit 141 which is itself coupled to the aerial.

Figure 3 shows a modification in which each discharge circuit includes a spark gap which is of such nature that the normal working potential will not spark but which is capable of being ionized by a second or trigger spark, which by reason of the shortness of its wave length and also because its circuit has little interaction with other circuits gives more accurate timing than is possible with the dischargers in the main circuits.

The main condensers 1 and 2, which are charged from

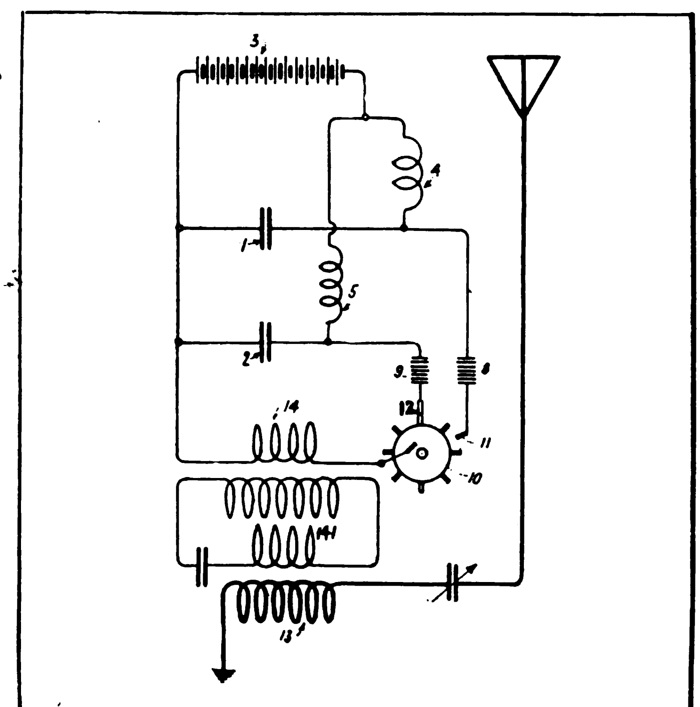


Figure 2—Modified circuit of figure 1

the high tension battery 3 or other source of supply through inductances 4 and 5, discharge through primary coils 6 and 7, quenching arrangements 8 and 9, the secondaries 15 and 16 of two small oscillation transformers and electrodes 11 and 12, respectively, to the main disc 10.

Auxiliary or trigger condensers 17 and 18, which are small in comparison with 1 and 2, are charged through

suitable inductances 19 and 20 from a high tension battery 21 or other source of supply. These condensers discharge through the primaries 22 and 23 of the small oscillation transformers, and electrodes 24 and 25, respectively, to a trigger disc 26.

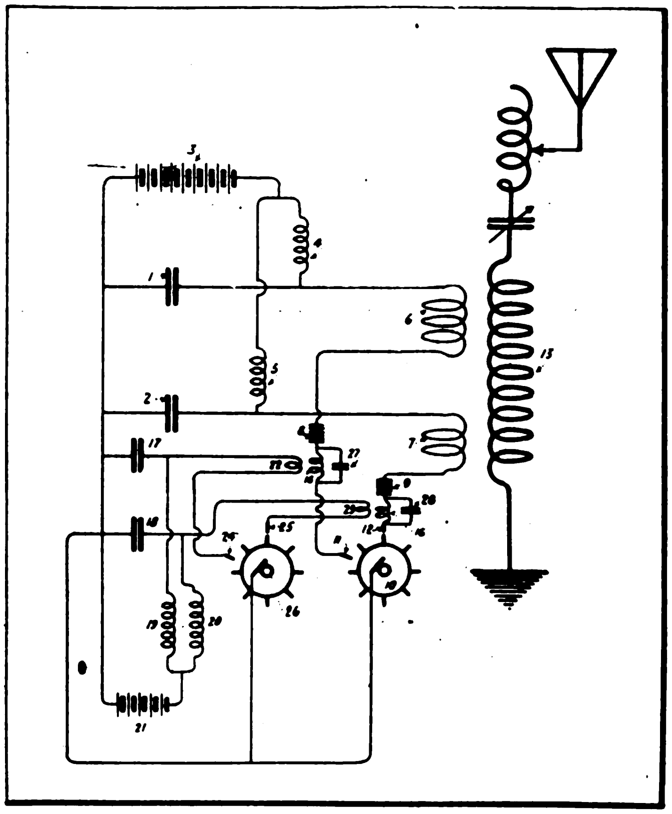


Figure 3—Showing the use of a trigger spark

This trigger disc is preferably coupled to the main disc 10 and the electrodes are arranged so that when a stud on 10 is opposite 11 or 12 a stud on 26 is opposite 24 or 25, respectively! The main circuits 1, 6, 15 and 2, 7, 16 are both coupled and tuned to the aerial circuit. The trigger circuits 17, 22 and 18, 23 have preferably a very much higher frequency than the main circuits; the secondaries 15 and 16 of the oscillation transformers are preferably shunted by small condensers 27, 28 placed across them and the circuits 15, 27 and 16, 28 are tuned to the trigger circuits 17, 22 and 18, 23, respectively.

Immediately either condenser 17 or 18 discharges, a high potential is induced in the oscillation transformer secondary 15 or 16 causing a spark at 11 or 12 thus allowing the main condenser 1 or 2 to discharge.

A Novel Radio Telegraph Aerial

THE ordinary receiving aerial responds best to radio signals, the frequency of which coincides with its natural frequency. It has also been observed that such an aerial system will oscillate at its own period when excited by electro-magnetic waves having a widely different period. This is particularly true when such electro-magnetic waves emanate from nearby powerful transmitters or are the result of atmospheric electricity.

Roy A. Weagant, chief engineer of the American Marconi Company, has made an exhaustive investigation of this phenomenon and he believes it to be due to the distributed capacity, inductance, and resistance of the aerial. He has found that by placing a series of coils in the antenna from the earth to the free end, the aerial takes on a characteristic which permits it to respond only to radio signals of the frequency to which the complete antenna system is tuned.

By adopting this construction he was enabled to eliminate the interference of transmitting stations operating on short wave lengths located in proximity to the large receiving aerial employed by the Marconi Company in transoceanic communication.

The fundamental construction is illustrated in figure 1, and a modification in figure 2. In figure 1 a series of inductance coils i, preferably of equal dimensions, and placed at substantially equal distances apart, are inserted in the antenna system. The usual receiving transformer is indicated by the primary coil 10 and the secondary coil 11. The presence of the coils i in the receiving antenna impart to it a fundamental oscillating characteristic, which blocks out oscillations of higher frequency than those which it is intended to receive.

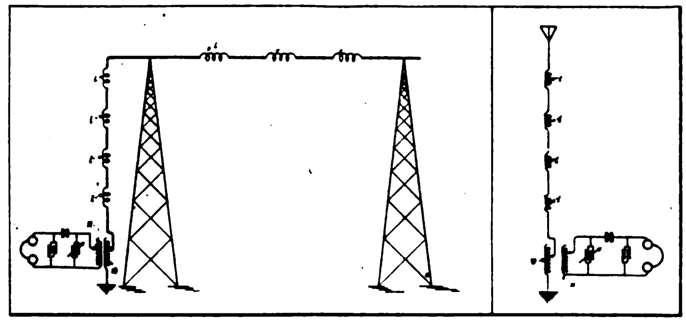


Figure 1 (right)—Showing new type of aerial with series of coils inserted
Figure 2 (left)—A modification of figure 1

In the ordinary aerial system, the antenna can be set into oscillation at its own natural period, either by the repeated application of minute impulses at the frequency of the antenna, or by shock excitation such as might be caused by one or more uni-directional impulses or oscillatory impulses of relatively great strength, but at a frequency differing from that of the natural frequency of the antenna.

Mr. Weagant declares the construction as in figure 1 to be so effective in this respect, that it became possible at the Marconi factory in Aldene, N. J., to receive signals transmitted direct from Nauen, Germany, with the ordinary factory antenna while the operation of testing transmitters in the factory building was going on. The inventor mentions that this aerial is most effective in the reception of continuous oscillations.

Method for Exhausting Vacuum Tubes

AS mentioned in previous articles it is highly desirable that the anode of a three-electrode vacuum tube be heated during the exhaustion process to free it of all occluded gases.

In the construction of vacuum tubes in which it is desired to maintain a high vacuum, it has been found that unless the electrodes and walls of the vessel have been subjected to a vigorous preliminary treatment, the gases retained by them will slowly leak out with the result that the vacuum is soon decreased and ionization by collision with the gas molecules can then take place.

This preliminary treatment is usually carried out by heating the walls of the vessel externally, and by directing a stream of electrons towards the anode or plate. These electrons upon striking the anode liberate all ionizable matter which may be removed in the pumping process.

To do this effectively it is essential that the energy of the striking electrons shall exceed their velocity during normal operation of the vacuum tubes.

An apparatus has recently been devised by Ellsworth Buckley, which provides for heating the anode by vigorous bombardment of electrons without endangering the cathode (or filament), this being the method by which gases are driven from the plate.

It has been found that in preparing vacuum tubes it is not allowable to draw from the cathode a much larger current than is used in normal operation, for the effect of that treatment is to disintegrate the cathode. The present

invention insures that the electrons striking the anode shall do so under the influence of a large voltage and consequently with large kinetic energy, while at the same time this large voltage is not able to draw more than normal current from the cathode.

In a thermionic device of the type described, if the potential of the auxiliary electrode is made negative with respect to the cathode a larger voltage between anode and

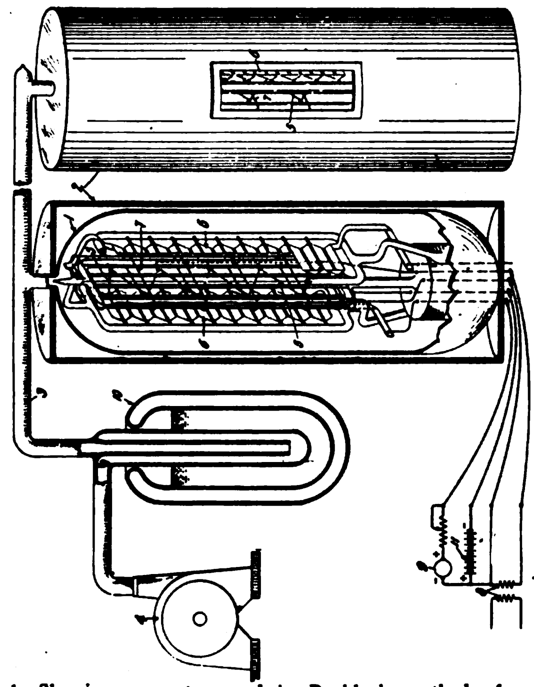


Figure 1—Showing apparatus used in Buckley's method of exhausting vacuum tubes

cathode is necessary to produce the same current from the cathode as would appear in the absence of such a voltage applied to the auxiliary electrode. But the kinetic energy of the electrons striking the anode increases with increased voltage, and it is therefore possible by applying a negative potential to the auxiliary electrode, to increase the voltage effective in driving electrons to the anode very much above the normal value, while maintaining the current at its normal value. By this process vigorous bombardment of the anode is possible without drawing more than normal current from the cathode.

Buckley's process will be more completely understood in connection with the drawing figure 1, in which 1 represents a vacuum tube of the usual type consisting of an evacuated vessel containing cathode 5, anode 6 and an auxiliary electrode 7. This vessel is inclosed in an oven 2 which may be heated externally. The glass tubing 3 serves to connect the tube with a molecular pump 4 or other suitable means for exhausting it. The liquid air-trap 10 is included in this line of tubing for the usual purpose. The filament 5 is heated by means of alternating current furnished to it through the medium of the transformer 8, whose primary winding is energized by means of the source of alternating current, not shown in the drawing. The voltage between anode and cathode is supplied by means of the direct current generator 9, while the electromotive force required to maintain the auxiliary electrode negative with respect to the cathode is obtained from the battery 11, whose negative pole is connected to the auxiliary electrode.

During the process of evacuation the pump is operated, the filament heated and a discharge started between anode and cathode. The battery 11 is then applied and the voltage of the generator 9 increased. The current through the tube is adjusted to approximately normal value and the bombardment of the anode at the increased voltage is continued until no evidence of gaseous ionization in the tube can be detected.

As an example of the voltages employed in one type of tube, it has been found that in the early part of the process a maximum of about 200 volts can be maintained between the cathode and the anode. By applying 110 volts between the cathode and the auxiliary electrode making the latter negative, a maximum of 500 volts or more may be obtained with consequent more rapid release of gas from the anode. In the later stages of exhaust a potential difference of 750 volts or more may be maintained by the use of the negative auxiliary electrode, while if that electrode were disconnected it would not be more than 550 volts.

A Combination Circuit for Tube and Crystal

THE English Marconi Company has developed a novel circuit for the combined or individual use of the vacuum tube and the crystal rectifier. The scheme of connections is shown in figure 1. C is short wave condenser, L is the antenna inductance, L-1 a coil which acts as a primary winding of a receiver tuner for use with the crystal detector D, or as a regenerative coupler for amplification by the vacuum tube. L-2 is the secondary of the tuning transformer for use with the crystal or a tuning element of the plate circuit for regenerative coupling in connection with the vacuum tube. C-1 is the plate circuit tuning condenser. D is a carborundum rectifier, P-1 a potentiometer, B-2 the plate battery, T a telephone transformer and P-2 a pair of low resistance telephones.

It will be clear, from close observation of the diagram, that if the filament F of the vacuum tube is cold, the crystal detector D alone may be employed to detect spark signals. L-1 is then the primary of the tuning transformer and L-2 the secondary. If, on the other hand, amplification of the incoming signal is desired, the filament F is brought into play. The grid

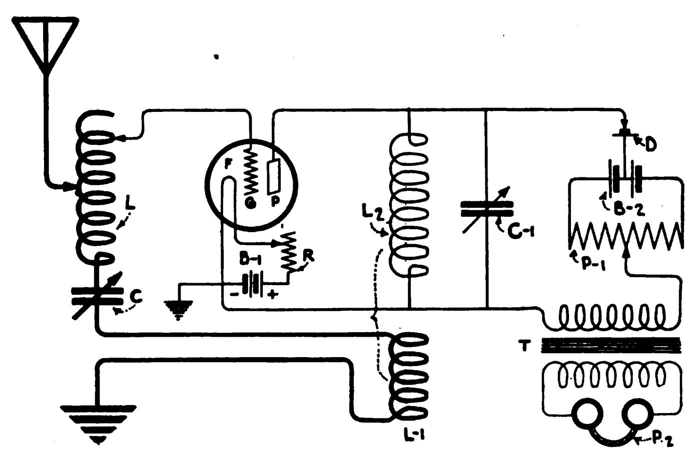
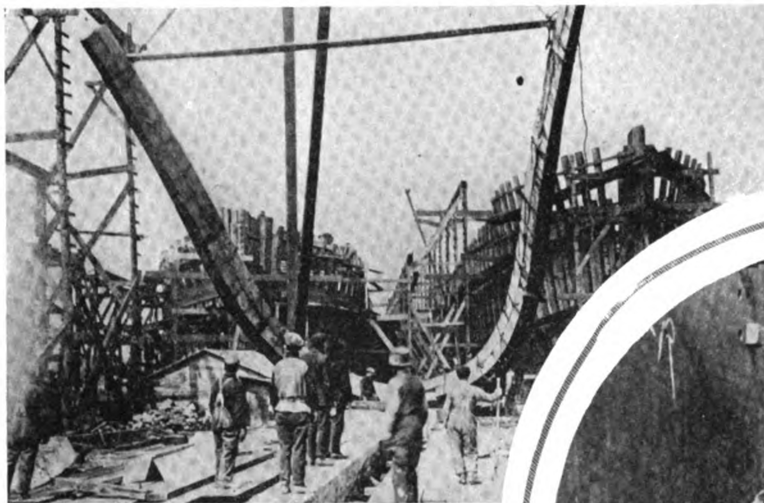


Figure 1—Circuit for the combined or individual use of vacuum tube and crystal rectifier

element G is then connected to the antenna inductance L and by suitable adjustment of the reaction L-1, L-2 and of the grid circuit potentiometer P-3 the circuits of the tube will be set into self-oscillation. The apparatus then receives by the phenomenon of beats or by careful adjustment of L-1 and L-2. Amplification of the incoming signal can be secured without the beat phenomenon.

There is thus provided a receiving apparatus which is independent of the vacuum tube, for should it become inoperative, such as by burning out of the filament, signals can still be received by the crystal detector alone. For longer distances, the vacuum tube circuits are brought into action for amplification. The apparatus clearly is responsive to undamped waves as well as damped waves.



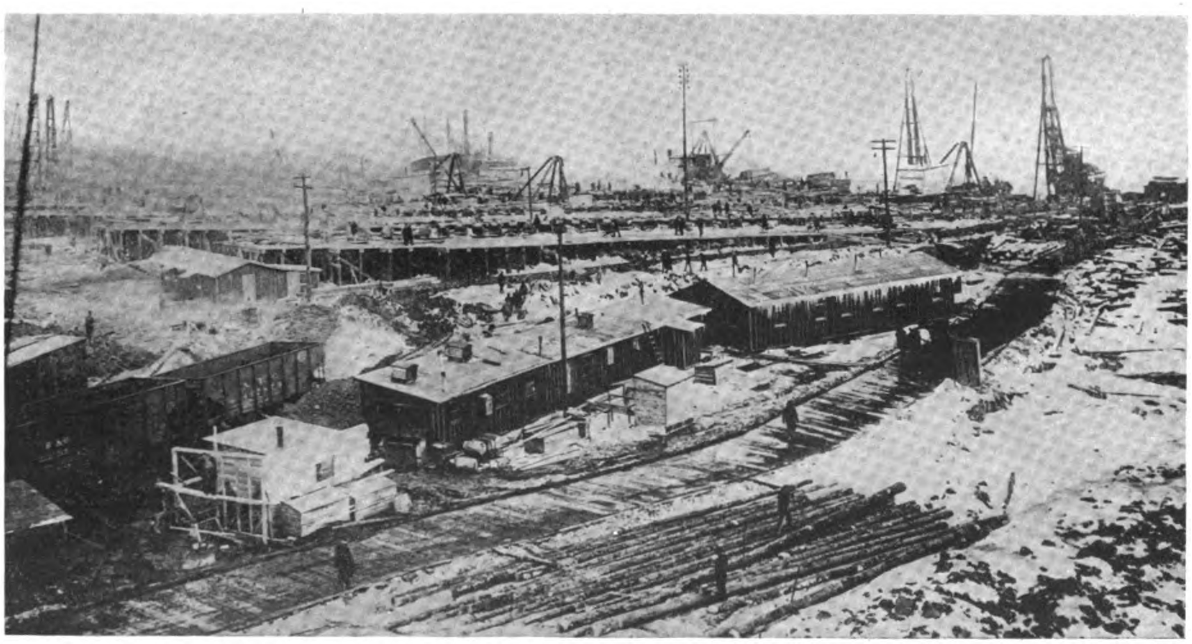
Photos: Underwood & Underwood

Building Ships for Uncle Sam

To the left, a shipyard scene as the first frame or rib of one of the standardized wooden vessels is raised in view of two partially completed sister ships

Above, in circle, one of the riveters with his electric machine endeavoring to maintain the high speed of his crew, record breaking which has astonished the world being a daily occurrence with these loyal workers

To the left, an underneath view of the belly of a wooden ship showing the calking of her seams in progress. So well are these wooden vessels constructed that Lloyds' give them an insurance rating as high as steel craft



A glimpse of the famed Hog Island shipyard, the largest in the world, though but 9 months old

Wartime Wireless Instruction

A Practical Course for Radio Operators

By Elmer E. Bucher

Director of Instruction, Marconi Institute

PART II—ARTICLE I

EDITOR'S NOTE—Part 1 of this series of lessons began in the May, 1917, issue of THE WIRELESS AGE. Successive installments were devoted to the fundamental actions of radio transmitting and receiving apparatus for the production and reception of damped oscillations.

Part 2, the present series, will deal with undamped wave generators, including bulb transmitters and receivers for the reception of undamped oscillations. The direction finder and other special appliances employed in radio telegraph work will be treated fundamentally. A discussion of the basic principles of wireless telephony will terminate the series.

The outstanding feature of the lessons has been the absence of cumbersome detail. The course will contain only the essentials required to obtain a government *first grade commercial license certificate* and to supply the knowledge necessary to become a first rate *radio mechanic*.

CONTINUOUS WAVE GENERATORS
DECREMENT AND TUNING

(1) The apparatus heretofore described in this series of lessons dealt with the transmission and reception of radio telegraph signals by means of damped oscillations. In the systems under consideration, these oscillations were produced principally by the **periodic discharge of a condenser through an inductance across a spark gap.**

(2) To insure selectivity, that is, discrimination between stations operating on nearly the same wave lengths, it is desirable that the **oscillations** in a wave train be **slowly damped out,** that is, the rate of decay must be reduced to a minimum.

(3) The United States Laws decree that the minimum damping of two successive oscillations must be .2 or less; that is, **the logarithm of the ratio of the amplitude of one oscillation to the next oscillation in a wave train must be .2 or less.**

(4) It has been shown that if the damping decrement of a wave train is known, the number of oscillations per wave train (assuming they have died out when amplitude of the last one is .01 of the first one) can be obtained from the following formula:

$$M = \frac{4.605 + \delta}{\delta}$$

where δ = the logarithmic decrement.

Thus a decrement of .2 corresponds to approximately 24 complete cycles in the antenna current for each spark discharge and similarly a decrement of .01 to 46 complete cycles.

(5) Modern wireless telegraph transmitters radiate wave trains the decrement of which is often as low as .03 per cycle corresponding to 150 or more oscillations in the aerial circuit for each spark discharge in the closed circuit.

(6) **When the decrement of a transmitter is low a slight change of inductance or capacity at the receiving station will eliminate the signals.** The factor of selectivity is accordingly high. On the other hand, **if the decrement is high, a relatively large change of inductance or capacity is required at the receiver to eliminate the signals.** The factor of selectivity is accordingly small.

(7) The desired low damping of the aerial currents in a radio transmitter is secured by the employment of a spark gap giving good **quenching** effects. The reaction of the aerial circuit on the spark gap circuit during the building up of the aerial oscillations is thereby prevented, permitting the aerial currents to decay at the natural damping of the antenna circuit. The insertion of loading coils at the base of the aerial aids in lowering the decrement.

(8) The sharpness of tuning or the adjustment for resonance in two coupled circuits is limited by the sum of two decrements, that of the impressed E.M.F. and that of the circuit being driven. The same applies to a radio transmitter and receiver. Hence it is obvious that a **transmitter employing undamped or continuous oscillations gives greater selectivity** than the damped system, for it is evident that the undamped or continuous oscillations possess no decrement. (Slight inequalities of amplitude exist in most continuous wave generators.)

(9) One of the great advantages of the continuous wave generator in radio telegraphy is the **syntonic** or **resonance** effects secured at the receiver, and, moreover, owing to the new principles of reception which such transmitters bring into play, the range of transmission has been remarkably increased.

(10) It should be known here that previous to the advent of the **vacuum tube generator** for continuous waves, a reliable short wave continuous oscillation generator was not available. The most commonly used undamped oscillation generator heretofore was the **arc generator,** which will not function uniformly at wave lengths below 1000 meters, the best results being obtained at frequencies corresponding to wave lengths above 3000 meters. The vacuum tube generators, on the other hand, will function at frequencies from a **cycle per second up to several millions.**

PROBLEMS INVOLVED IN THE RECEPTION OF CONTINUOUS AND DISCONTINUOUS WAVES

(1) It is frequently of advantage to make a comparison of the continuous and discontinuous wave system in respect to the methods of reception.

(2) Since the **telephone** is almost universally used to record radio telegraph signals, it is convenient to consider the problems of reception from the standpoint of this piece of apparatus. It has been established that a **current which impulses the diaphragm of the telephone receiver from 100 to 1000 times per second gives the maximum response, with a given current.**

(3) In the discontinuous wave transmitter the currents induced in the receiving apparatus are already modulated at an **audio frequency** by the charging current at the transmitter, but it is plainly evident the energy radiated by a continuous wave generator will produce no effect on the receiving telephone because, for example, if a rectifier is connected in the receiving circuits the telephone diaphragm will be impulsed by direct current pulses occurring at radio frequencies.

(4) **Radio frequency currents in excess of 20,000 per second will not give audible response in a telephone, but a rectified radio frequency current if broken into groups of say 200 to 1000 per second will give audible response with a minimum of current.**

(5) In the case of the reception of undamped oscillation, we are compelled to break up the incoming currents at the receiving station into audio frequency groups either by **mechanical** or other means.

(6) The **tikker** and the **slipping contact detector** are simple circuit interrupters arranged to vary the incoming currents at the receiving station at audio frequencies. The **tone wheel** is a form of tikker which is in reality a partial rectifier producing audio frequency telephone currents. The **beat receiver** produces audio frequencies by the interference of two radio frequency currents, one of which is generated locally and the other, the incoming signal.

When this method of reception is combined with the amplifying properties of the vacuum tube enormous distances of transmission are possible

TYPES OF CONTINUOUS WAVE GENERATORS

(1) The most commonly used type of continuous wave makers are:

1—The Poulsen Arc generator.
2—The Vacuum Tube generator (sometimes called the bulb transmitter).

The other types are:

1—Alexanderson Radio Frequency Alternator.
2—Goldschmidt's Radio Frequency Alternator.
3—The Multiple Frequency Transformer system.
4—The Over-lapping Wave Train system (Marconi System.)

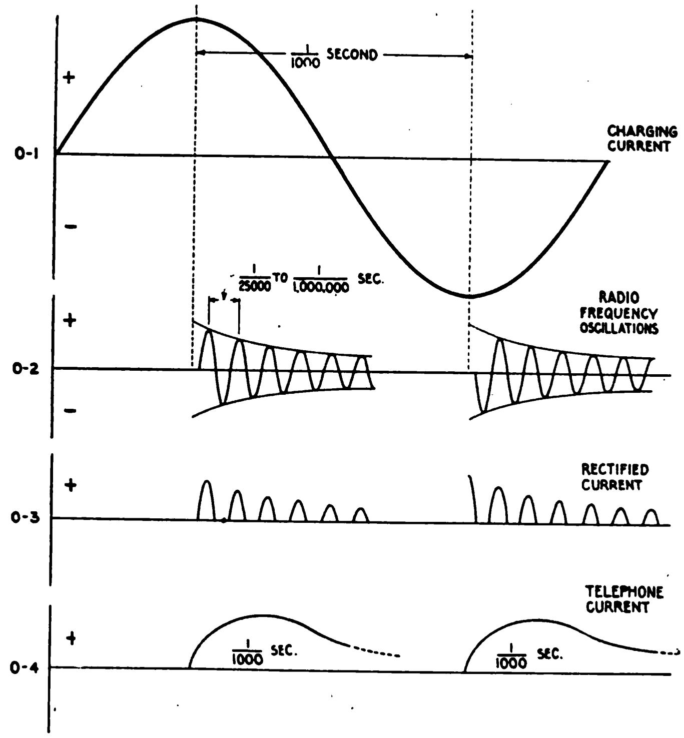


Figure 181

OBJECT OF THE DIAGRAM

To show graphically the fundamental principles involved in the transmission and reception of wireless telegraph signals by means of apparatus for the production of damped oscillations.

DESCRIPTION OF THE GRAPHS

Graph O-1 shows the audio frequency charging current applied to the high voltage condenser in the closed oscillation circuit of the transmitter; graph O-2 the resulting radio frequency currents induced into the antenna circuit of the transmitter which also may be taken to indicate the currents impressed across the oscillation detector (crystal rectifier) at the receiver; graph O-3 the rectified currents in the receiving circuits, and graph O-4 the approximate telephone current.

OPERATION

The frequency of the condenser charging current at the transmitter is assumed to be 500 cycles per second, and since **in a synchronous gap transmitter the condenser is charged and discharged once for each alternation of the charging current,** the spark frequency will be 1000 per second.

Each discharge at the spark gap will induce in the antenna circuit a **group of radio frequency currents,** such as shown in graph O-2. It should be noted that the time period of one alternation of the charging current is 1/1000 of a second, whereas the time period of a complete cycle of the resulting radio frequency currents may vary in commercial practice from 1/25000 to 1/1000000 of a second, depending inversely upon the square root of the product of the inductance and the capacity of the circuit.

Currents of the same frequency will be impressed across the oscillation detector at the receiver, where they are rectified, giving (assuming perfect rectification) the uni-directional pulses shown in the graph O-3. **These pulses occur at rates above audibility** (for it must be remembered that the telephone will not give audible response to radio frequency currents), but since they have the same general direction the telephone diaphragm responds to an average effect as shown in the graph O-4.

SPECIAL REMARKS

(1) It is evident from the foregoing that a 500 cycle synchronous transmitter will give 1000 spark discharges, per second and **each spark discharge will induce in the transmitting aerial a group of radio frequency currents.** Each group will radiate a **train of waves.** A 500 cycle transmitter will, therefore, radiate into space 1000 of wave trains.

(Continued at bottom of second column)

(Continued from first column)

(2) Following the actions to the receiver, it is seen that each spark discharge at the transmitter eventually sends a **pulse of direct current through the receiver.** Therefore, 1000 sparks at the transmitter will deflect the diaphragm of the receiver telephone 1000 times and **the pitch of the note emitted by the telephone diaphragm** will be substantially the same as that of the spark discharge at the transmitter.

(3) This accounts for the use of 500 cycle currents in spark radio telegraphy, for they impulse the telephone diaphragm at such rates as to cause it to emit musical sounds.

Two advantages are derived in the use of high spark frequencies:

(a) The telephone gives maximum response when it is impulsed at rates near to 1000 per second.

(b) It is less difficult for the operator to distinguish between wireless telegraph signals and the interfering discharges of atmospheric electricity.

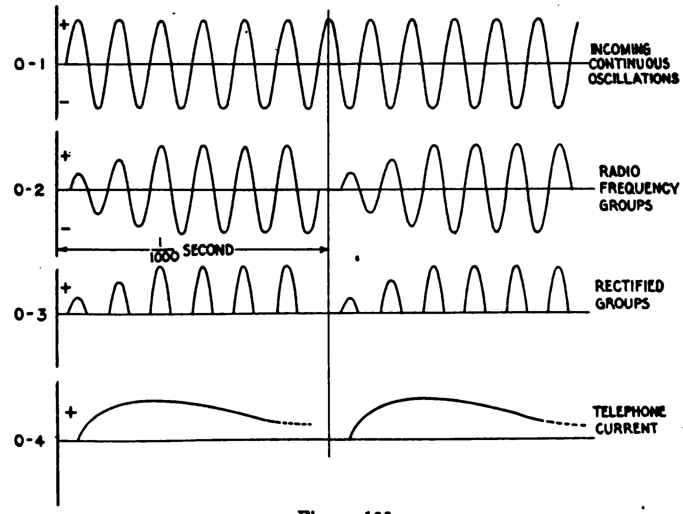


Figure 182

OBJECT OF THE DIAGRAM

To show the problems involved in the reception of continuous oscillations such as may be generated, for example, by a radio frequency alternator, and to offer a comparison of the continuous wave system with the discontinuous wave system.

PRINCIPLE

Because the wave motion radiated by a continuous or undamped wave transmitter is not broken into groups, as in the discontinuous or damped wave wireless system, it becomes necessary to interrupt the incoming currents at the receiving station at audio frequencies in order to secure the maximum of response from a telephone diaphragm with a minimum of current.

DESCRIPTION OF THE DRAWING

Graph O-1 shows a **train of incoming continuous oscillations** such as flow through the receiving circuits of an undamped wave receiver. Graph O-2 indicates the **resulting groups of radio frequency currents** when the incoming currents are interrupted mechanically, such as by use of the well-known tikker. Graph O-3 shows the **rectified groups of radio frequency currents** resulting if a rectifier is employed in connection with the tikker, and graph O-4 the **resulting telephone current.**

SPECIAL REMARKS

(1) The graphs indicate only the results secured by the combined use of the tikker and crystal rectifier, but somewhat similar effects are obtained from the beat receiver (heterodyne or beat system, as it is sometimes called), to be described further on.

(2) It is to be noted that the telephone current is approximately the same in the graphs in Figures 181 and 182.

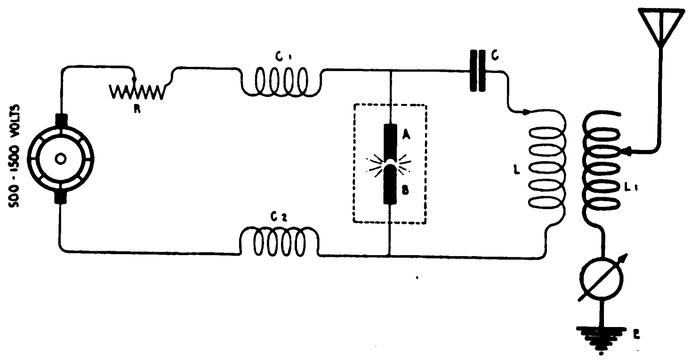


Figure 183

OBJECT OF THE DIAGRAM

To show the fundamental circuits of the Poulsen arc generator.

PRINCIPLE

Because of the "falling characteristic" of the D.C. arc, in other words, its instability, an inductance-capacity circuit may be shunted across the arc for the production of continuous oscillations.

DESCRIPTION OF THE DRAWING

The arc gap is represented by the **copper** and **carbon electrodes** A and B. The gap is energized by the D.C. generator at voltages from 500 to 1500 volts. R is a ballast or **regulating resistance.** C-1 and C-2 are **iron-core choke coils** to prevent the radio frequency currents flowing in the circuit L, C, AB, from discharging back into the generator. C is the **condenser** and L the **primary inductance** of the oscillation transformer. L-1 is the **secondary inductance** connected in series with the antenna as usual.

OPERATION

The functioning of the arc generator for the production of continuous oscillations can be explained in the following way, but it must be understood that the mode of operation under some adjustments are very complex and require classification, in other words the arc is capable of **generating several types of oscillations,** certain of which are desirable and others distinctly undesirable.

It is to be understood that the **gaseous section** of the arc **does not possess constant resistance,** and it, therefore, does not obey Ohm's law, that is:

(a) If the potential difference across the arc is high, its resistance is large and the flow of current is relatively small.

(b) If the potential difference across the arc is low, its resistance is low and accordingly the flow of current is relatively large.

In the region of current flow corresponding to the conditions in (b) the arc is unstable and unless a balancing resistance be inserted in the supply leads from the D.C. generator, the arc will become a short circuit.

It is clear from (a) **that a small increase in potential difference across the arc results in a small decrease in the arc current.** Since this phenomenon is the reverse to that encountered in ordinary circuits whose resistance is constant, the arc is often spoken of as a **negative resistance.**

In the case of the Poulsen arc generator, the operation of the **closed circuit** in practice is assumed to be as follows, but it should be added that it is doubtful whether this sequence of events remains strictly constant throughout an operating period.

(1) Assuming the arc to be in operation and the condenser connected in shunt: The condenser accumulates a charge, thereby robbing the arc of some of its current.

(2) The decrease of current through the arc in accordance with (a) above corresponds to increased potential difference across the arc.

(3) The condenser therefore continues the charge until the arc voltage becomes stationary.

(4) The condenser then discharges through the arc, increasing the arc current.

(5) In accordance with (b) above, the arc voltage therefore decreases and it thereby assists the discharge of the condenser.

(6) The discharge current from the condenser through the circuit L, C, AB, operates, as in any oscillation circuit, to recharge the condenser in the opposite way.

(7) When the condenser now discharges, its current flows against the current of the arc, and if the condenser current is equal to the arc current the arc goes out.

(8) The condenser cannot therefore complete its discharge, but the supply current is now diverted from the arc and hence it acts to oppose the residual charge in the condenser reducing it to zero.

(9) The supply current then acts to recharge the condenser in the way mentioned at the beginning, that is, it charges the condenser to the voltage necessary to re-ignite the arc discharge, whereupon the cycle of operations is repeated.

(10) The frequency of the resulting oscillations will only approximate that to be expected from the values of L and C. This is due to the fact that the time between the reduction of the arc current to zero and the commencement of the next discharge depends upon the rapidity with which the supply current can recharge the condenser. The arc is therefore apt to oscillate at a fundamental and several harmonic frequencies.

SPECIAL REMARKS

(1) As mentioned previously, several types of oscillations may be generated by the arc system. It is usual to classify them as types I, II, III. Type I represents the case where the **oscillation current is always less than the arc current;** type II, where the **condenser current is the same as the arc current;** type III, where the **condenser current is greater than the arc current.**

Type I oscillations are generally of little importance as the efficiency of conversion is low. Type II oscillations are assumed to be those encountered in the practical operation of the Poulsen arc. The resulting oscillating current is partly a sine wave alternating current and partly a D.C. current. Type III oscillations (due to the lag in the cooling of the arc gap) causes an actual reversal of current across the arc, and the condenser is therefore not recharged by the supply dynamo until the oscillating current has gone through a few swings; in other words, in a circuit where type III oscillations exist, there results groups of damped oscillations much similar to those obtained in spark radio telegraphy.

(2) It is found that the best results are obtained when the **direct current voltage is from 500 to 1500 volts** and the **positive arc electrode is rapidly cooled.** Water is generally circulated through the positive electrode, which is hollow and of copper. The rapid cooling of the arc assists in producing energetic oscillations because it allows the arc to die out rapidly and shortens the time of the condenser charging period.

(3) Increased efficiency is secured, that is, more energetic oscillations are obtained by surrounding the arc with **hydrogen gas.** The gas assists in cooling the ionized vapor between the arc electrodes. **Illuminating gas, alcohol, ether** or **steam** can be used in place of hydrogen.

(4) The oscillations are made still more vigorous by the application of a **magnetic field at right-angles to the arc.** The action of this field is to **deflect the arc to one side,** thereby **increasing its length and consequently the potential difference.** The magnetic field also assists in **blowing out** the conducting ions formed in the gas, thereby increasing the potential difference between the electrodes. This has the effect of giving the condenser an increased charge.

(5) Satisfactory operation is secured only by establishing the correct relation between the **strength of the magnetic field,** the **arc current** and the **length of the arc.** These adjustments are obtained by experiment.

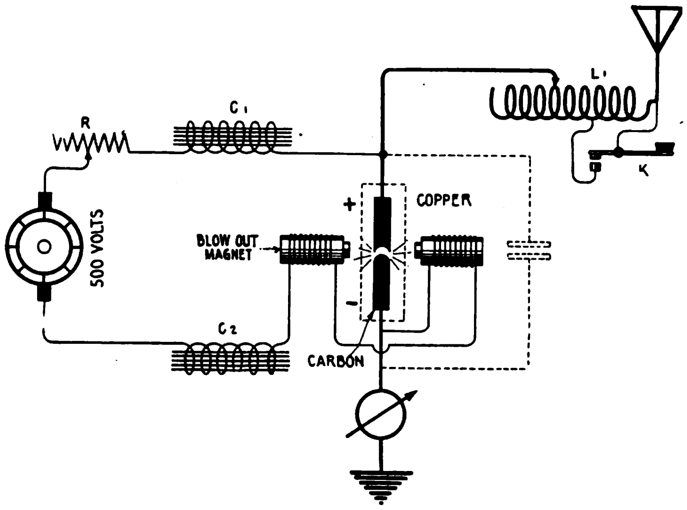


Figure 184

OBJECT OF THE DIAGRAM

To show the fundamental circuits of a modern arc transmitter.

DESCRIPTION OF THE DRAWING

A 500 cycle D.C. dynamo supplies current to an arc gap consisting of a **positive electrode of copper** and a **negative electrode of carbon** enclosed in a **containing vessel** to which is supplied **hydrogen** or **illuminating gas.** In series with the supply mains are placed **powerful electromagnets** which are mounted at right-angles to the arc gap. The supply mains also include the **iron coke choke coils** C-1 and C-2, and a **ballast resistance** R which prevents the arc from effecting a short circuit. The coils C-1 and C-2 help to maintain the supply current at a constant E.M.F. (there is some argument on this point, for it is believed that these coils act in some circuits to cause a potential difference across the condenser that greatly exceeds the voltage of the supply generator).

The important feature of figure 184 is that the arc gap is connected directly in series with the aerial circuit.

The length of the radiated wave is varied by the aerial inductance L-1.

Signaling is accomplished by means of the key K, which shunts a portion of the aerial tuning inductance; thus when the key is up the antenna radiates a short wave, and when the key is down it radiates a longer wave. If the receiver is tuned to the wave length emitted when the key is down, the signals that are radiated when the key is up, will not be received; in other words, signaling is effected by changing the wave length of the radiated wave.

The function of the condenser (in dotted lines) shunted around the arc is to act as a bypass for the radio frequency currents of the aerial circuit, thereby avoiding the necessity of passing the entire antenna current through the arc.

SPECIAL REMARKS

(1) It is through the features shown in figure 184 that the arc transmitter has been brought to the degree of perfection required for commercial application.

These features are:

(a) Placing the arc in an atmosphere of hydrogen.

(b) Using a carbon electrode for the negative side and a water cooled copper electrode for the positive side.

(c) The employment of a transverse magnetic field.

(d) Slowly rotating the carbon electrode by a small motor (not shown in the drawing).

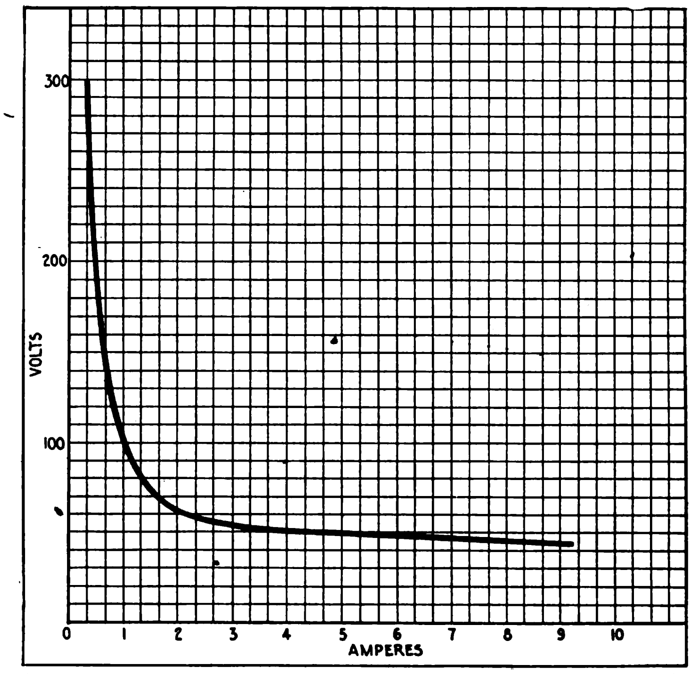


Figure 185—Showing the so-called static characteristic of the arc, that is, the relation between potential difference and arc current when D.C. current is applied to the arc gap. The important point to be observed is that large arc currents correspond to a small potential difference whereas small currents correspond to a high potential difference. This phenomenon is accounted for by the fact that if an increase of arc current is produced by increasing the E.M.F. from the source of supply, greater heat is produced at the negative electrode and therefore greater ionization. The increased number of electrons thus made available for conduction, results in increased conductivity or lower resistance. The supply E.M.F. is therefore enabled to cause an increased flow of current which continues and the voltage required to maintain the arc decreases towards a definite minimum.

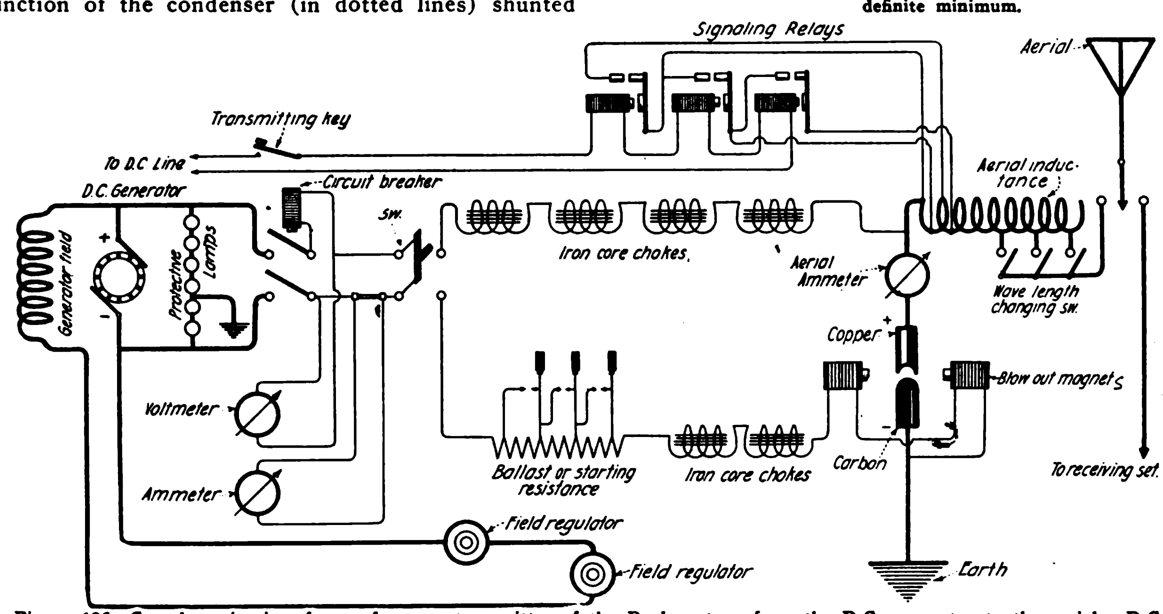
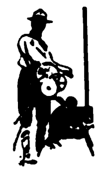


Figure 186—Complete circuits of a modern arc transmitter of the Poulsen type from the D.C. generator to the aerial. D.C. current at 500 to 1500 volts is fed to the arc gap by a generator with variable field resistance. The starting resistances permit regulation of the arc current for maximum efficiency and prevent short circuit of the generator during the preliminary adjustments. The iron core choke coils serve to protect the generator from the radio frequency current flowing in the antenna circuit. Protective lamps are connected across the generator and earthed as shown, four lamps in series on the positive side and two lamps in series on the negative side. Powerful blow out magnets are placed at right-angles to the arc gap. The arc discharge takes place in an atmosphere of hydrogen or illuminating gas. The wave length of the transmitter is varied by cutting in and out turns at the aerial tuning inductance. Maximum aerial current is observed by the aerial ammeter. Signaling is effected by magnetic relay keys which short circuit a portion of the aerial tuning inductance thereby changing the length of the radiated wave.

Signal Officers' Training Course*

A Wartime Instruction Series for Citizen Soldiers Preparing for U.S. Army Service



By Major J. Andrew White

Chief Signal Officer, American Guard

Eighteenth Article—Coast Defense Information in War

IN general it appears evident that the service of security and information in coast defense, as in the field, implies, first, the collection of military information or intelligence; second, its transmission; and, third, its correlation and use. In regard to the first of these elements it may be said that the **collection of information** is primarily the duty of the coast patrol, but in war becomes the duty of the mobile army, the fixed defenses, and of every man of the government service, both civil and military, and, indeed, of all people of the country. But although important information may thus come from many sources and, no matter what the source, should be transmitted to proper authority, yet incidental information, like incidental soldiering, is merely auxiliary to the organized service of information. The continued value of this service depends upon a properly organized corps of men who will transmit the reports of trained observers from the aircraft, signal, and observation stations, from lighthouses and other government establishments. from the floating auxiliaries and ships as well as from chance sources of information, and from the thousand watchers of the coast, upon all of whom reliance must be placed in war to collect that information upon which will depend the attitude of the defense.

But both judgment and experience in regard to the weight to be given this information will be needed by officers and men in charge of this service, and of its transmission, if a constant condition of unrest and excitement is to be avoided at inshore terminals. Who can doubt, for example, that information received at the centers of control will determine the attitude of the army of the defense in threatened areas, and perhaps its ability to prevent surprise or repel attack; that the news or no news, often equally important, from the coast will govern the preparedness and vigilance of the mobile troops and supports and keep the artillerymen at the guns or give them release; that, in short, a well-organized service provided with trained men skilled in the use and maintenance of lines of information will relieve the defense of the greater part of its strain in the absence of the enemy, multiply many times its efficiency in his presence, and permit the smaller force to do the work of the larger. While, on the other hand, an insufficient service of information, handicapped by slow, inaccurate, or faulty transmission, will plague and worry the defense with useless anxieties and alarms, if it does not even lead on to disaster.

British Off. Photo

Coast artillery fire control utilizes the searchlight for code flashing

The **transmission of information,** which is the second element of the service of security, is a duty of vital importance, which should be intrusted only to trained men under military control, supplied with the best known appliances for this service, and should never be left to the chance efforts of any irresponsible person who can use a telegraph key or a radio instrument. In other words, that the section of the coast guard to which **the duty of transmission of information is intrusted should be composed of men trained in naval and military signaling and familiar with the methods of the Signal Corps of the army.**

With the use that will be made of the information when received, which is the third element of the service of security, the patrol has no concern, since this will depend upon commanding generals, and the reception and correlation of reports upon staff officers at headquarters, presumably signal officers, whose duty it should be to formulate and weigh the information transmitted.

It appears that the coast patrol will become in the future one of the strongest arms of that service of security and information upon which so much dependence is necessarily placed in modern war. It follows, and it cannot be doubted, that this patrol or guard when organized should be thoroughly efficient in numbers, personnel, organization, and equipment, and that its men, who are frequently placed at lonely stations and required to act upon their own initiative, should be not only steady, well-disciplined soldiers, but in addition must be carefully selected, intelligent, and keen men, skilled as observers and trained in the use of the telegraph and of mechanical appliances. Besides all this they should possess that judgment which seldom blunders in its work. Fortunately for the country, men of this character are many in civil life and will be found in abundance when called, but these men must be trained as soldiers.

The work of installing the fire control was formerly performed by the Signal Corps of the army, and many of the types of instruments used have been designed

*This article is abstracted from General Scriven's tactical observations, contained in the complete volume, "Military Signal Corps Manual," by Major White.

or adapted by the corps. But in addition to the fire-control systems there must exist both within and without artillery districts the fifth factor of the coast defense, that is lines of information, whether electrical or visual, by means of which artillery headquarters are kept in touch with the interior of the country and with centers of control; the factors and elements of the defense are brought into co-ordination; fixed positions connected; and the district bound into a whole under control of its commander, as an army in the field is linked together and maneuvered by its general.

These units are, as a rule, separated from each other by considerable distances. Each headquarters, however, is kept in touch with the others electrically, mainly through the commercial systems of the country; but the commercial systems are, of necessity, frequently supplemented by military lines, which extend them to artillery headquarters.

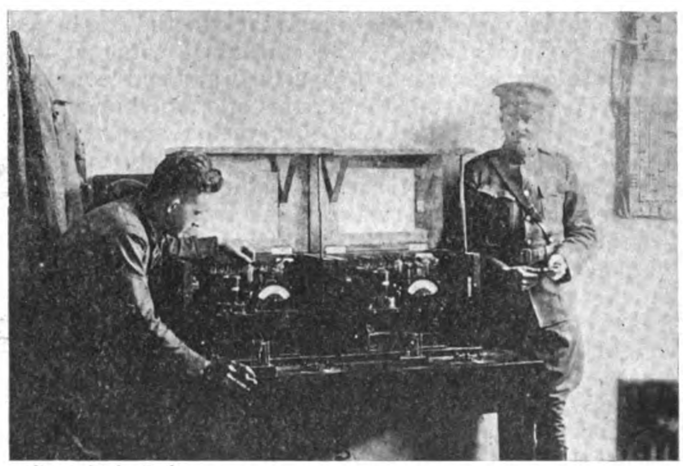
Press Illus. Svce.

For coast defense, means must be at hand for providing temporary lines of communication

In general, artillery lines of fire control and of information (except the field lines necessary in maneuvers) are, in peace, permanent in type; but in war to permanent lines are added a network of temporary systems as flexible and extensive as need be, and in character resembling those of an army in campaign. These may be more limited in extent, perhaps, but based on more stable conditions they are consequently easier to install and maintain against interruption by an enemy, except in the case of the radio. If interrupted, repairs are easier made, since the material should always be at hand at the fixed positions. But as with lines of information in the field, those of the coast defense, both permanent and temporary, must be certain and speedy. They will be more complicated and varied than is possible with the former, since they imply, in addition to land lines, systems of information extending both under and over the sea, and include in their scope every known method of transmitting intelligence from the wink of the ardois, the flash of the searchlight, the tick of the telegraph key, or call of the buzzer to the message of the long-distance radio and of the airplane or dirigible.

With the permanently laid lines of the coast defense transmission should, of course, be as efficient and satisfactory as in civil life if the systems are properly installed and skillfully operated in practice; but in order to secure these results it is evident that the ponderous permanent systems of the fixed defenses, both fire control and information, cannot be thrown out in an hour like the wires of a marching army, but must be carefully planned and constructed in advance as the defenses themselves are planned, must progress to completion with them, and when in place must be proof against reasonable probability of interruption.

Temporary lines will, of course, be installed only when demanded by the exercises and maneuvers or by the exigencies of war. Nevertheless, the means of providing them should be at hand within each artillery district, so that when needed field telegraph and buzzer lines may be laid easily, quickly, and without confusion from district headquarters to the supports, mobile troops, to headquarters and observation stations of the coast patrol. The telegraph and telephone, radio sets and visual appliances should be in readiness for use in the exchange of signals between the fixed positions and coast-defense ships, patrols, picket boats, and scout ships, as well as torpedo planters and the cable ship when necessary, and with the navy. The field telephone should be ready to tell its story from observation stations and the airplane and dirigible should be at hand to send by radio or visual signals their messages from land or sea. Thus the temporary lines of artillery districts will include many aerial systems, and even the permanent communications will not be electrical alone. Both will depend largely upon the auxiliary, but still very important, class of visual and oral signals, which before the introduction of the radio telegraph were the only means known of exchanging ideas without material connection. Visual signaling is probably more important in coast defense than with the army in the field and is vital when communication is needed between ships and shore and the radio is silent. Whether all the signal apparatus outlined will be used by the defense is another matter; still the possibility exists, and the fact remains that opportunity should be given those who have control to employ every method of transmitting information that may prove reasonably valuable. To do this it is necessary that signal appliances of all useful kinds be stored in depots within artillery areas, in addition to the material required for the emergency repair of permanent systems.



Com. Pub. Inf.

A duplex set for long distance communication such as is required in war to supplement existing commercial systems

In war the headquarters of each artillery position, even more than coast patrol stations, becomes a nucleus of intelligence regarding events at sea, and therefore the service of information in and from these districts should be as perfect as it can be made.

Signal Corps News

Officers' Training Centralized at Yale

Men seeking commissions in the Signal Corps of the army will receive their training at Yale University, it is announced. This centralizes training in this branch and makes possible full use of the university's faculty, which will be further augmented. The instruction personnel will be civilian and not military, although students enrolled will be in uniform, and officers, some of them coming from the front, will keep in close touch with the university.

Men detailed from the Government Radio School for Signal Corps officers are already arriving at Yale. About 100 have been transferred from College Park, Md., and others are coming from all parts of the country. These men are graduates of electrical engineering courses or are especially qualified for the work. Eventually there will be 300 men under training in this course, which will cover three months.

British Off. Photo

Apparatus captured by the British from the Hun who used it to generate electricity for their wireless stations

✤ ✤ ✤

Rank of Ensign in Army Urged

According to the American Army Gazette, a bill is being prepared to recreate the rank of ensign in the army for men who will be non-commissioned officers appointed by the Secretary of War and will rank below a second lieutenant, but above a first sergeant and a sergeant-major.

The need for a rank of this kind cannot be gainsaid. The pay of the non-commissioned officers of the army at the present time, while commensurate perhaps in some cases with their duties, does not begin to compare with the pay of the petty officers of the navy who are doing practically the same character of work. At the present time, outside of master engineer, master signal electrician and master electrician, there is no rank in the army corresponding to the ranks of boatswain, carpenter and gunner in the navy.

The proposed bill will allow the Secretary of War, upon recommendation of commanding officers, to issue warrants conferring the rank of ensign upon sergeants and corporals who have had more than six months' service, who will receive pay at the rate of $110 a month; not only in the line, but in specialized branches of the service, such as the signal, electrical, engineer, artillery and coast artillery corps.

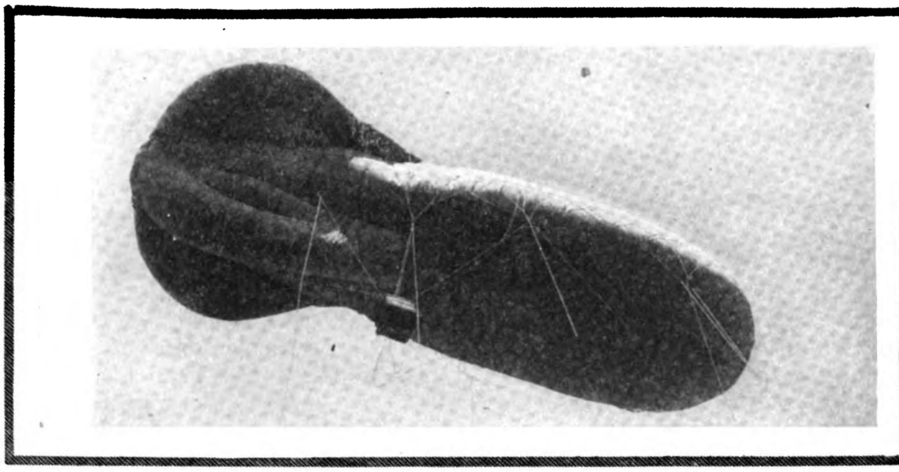
The details of the proposed act will closely follow the lines of the law for warrant officers in the navy.

The fact that at present men of highly specialized ability are daily being inducted into the army and immediately given duty for which in civilian life they received hundreds of dollars a month, and for which in the army they receive but $30 a month, does not make for a high morale in the enlisted personnel.

Instances without number might be cited of men in the army who are to-day working side by side with civilians doing the same character of work, and for which they are receiving one-fifth to one-tenth as much pay, because the civilian is perhaps incapacitated for service either by physical disability or by age limit.

The principal reason, however, for the need of a measure such as is proposed is to take care of the line soldier. Many men in the army who have risen step by step to the grades of corporal and sergeant, and have shown their peculiar adaptability for army life, are still hardly qualified for a commission. It is ridiculous to pay some of these men the paltry sum of from $44 to $60 a month in these days of high wages.

Scenes at the Army Balloon School

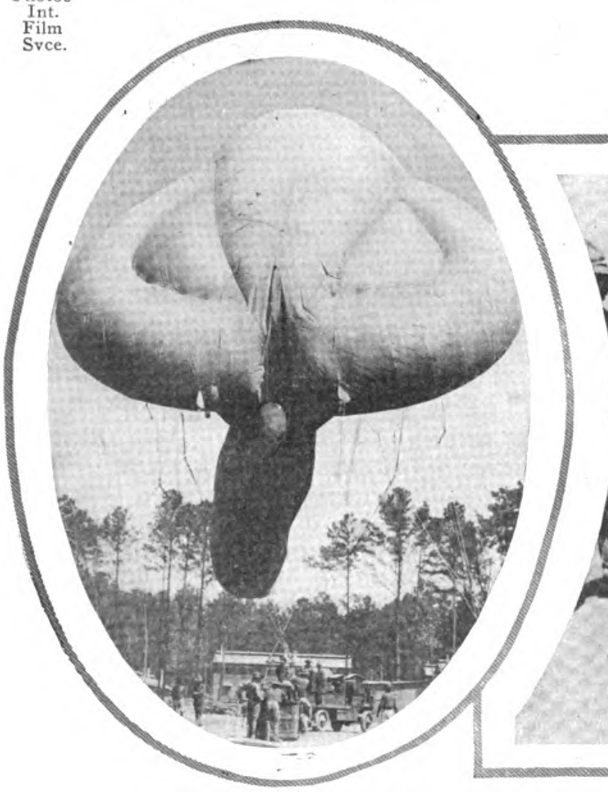


From observation balloons like the one illustrated above the skilled army observers spot the hits of artillery shells and make general tactical reconnaissance notes for the commanding general. These captive craft are ordinarily placed several miles back of the scene of combat and are protected by a patrol of combat airplanes. Reports are made by wire telegraph and telephone and by radio

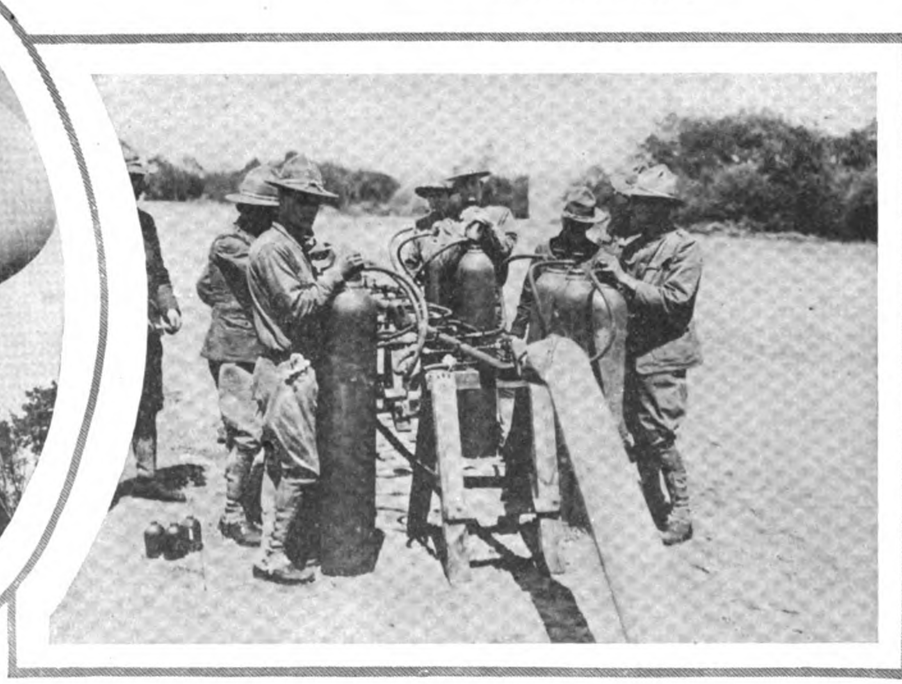
To the left, Major General W. L. Kenly, Chief of the Bureau of Military Aeronautics in conference with Major Burwell

Photos Int. Film Svce.

When the observation balloon is to be lowered the engine installed on the bed of this truck operates a winch around which the steel anchor cable is wound



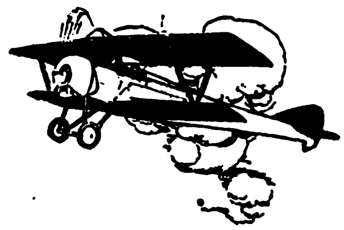
One of the big gas bags in mid-air; rear view, showing the ballonet and rudder inflated



The ground crew with the steel bottles which fill the balloons with gas. This gas is hydrogen, supplied by electrolytic generators, or made from ferro silicon and caustic soda

How To Become An Aviator

The Sixteenth Article of a Series for Wireless Men in the Service of the United States Government Giving the Elements of Airplane Design, Power, Equipment and Military Tactics



By J. Andrew White and Henry Woodhouse

Preparations for Cross-Country Flight

QUALIFYING tests for Junior Military Aviator prescribe two cross-country flights, one of approximately 60 miles and the other 90 miles. When these flights are undertaken the student aviator is expected to know all the fundamental technique of flying, turning and landing, and have reached the stage where the operation of controls is no longer a task but a matter of instruction routine, so to speak; in flying cross-country, therefore, he is enabled to give a large share of attention to following the course and selecting proper places should an emergency landing be required. Prior to the flight a few matters of importance require attention:

EQUIPMENT

The usual flying clothing is worn, the only caution being to provide for sufficient warmth. Leather suit and helmet are worn, supplemented in winter by sweaters and mufflers. Hands and feet are most sensitive to cold and should be well protected; provision of large boots with wooden socks or stockings will repay the aviator in comfort. On a long flight it is well to take two pair of goggles, in case one pair should be lost or broken, and a handkerchief to clean them is necessary. An identification card and money should be carried for emergencies; the telephone number of the airdrome should also be noted and a complete set of tools and covers for propeller and cockpit should be carried.

STANDARD EQUIPMENT—AIRPLANE TOOL CHEST

(Cover.)

1 Saw, hand, 26".
1 Hammer, riveting, 8 oz.
1 Combination square, bevel and level, 12".
1 Rule, folding.
1 Hacksaw, frame.
1 Dividers, pair, 6".

(Top.)

1 Wrench, Stillson, 14".
1 Screwdriver, 8".
1 Screwdriver, 7".
1 Screwdriver, 5".
1 Nailpuller.
1 Knife, draw 8".
1 Hammer, tinsmith's, 1 pound.
1 Hammer, claw.
1 Tape, steel, 100 feet.
1 Brace, 10".
1 Iron, soldering, 1½ lbs., 1 iron, soldering, jeweler's.
2 Center punches.
24 Blades, Hacksaw, coarse; 12 blades, Hacksaw, fine; 1 Chisel, cold, ¼"; 1 Chisel, cold, ½".
1 Calipers, 6".
1 Wrench, monkey, 6".

(Upper Drawer.)

1 Bit, expansive, ⅞ to 3".
1 Pliers, round nose, 6".
1 Pliers, snipe nose, 4".
1 Pliers, adjustable, 8".
1 Pliers, side-cutting, 8".
1 Pliers, adjustable, 6".
2 Pliers, auto, combination cutting, 6 and 8".
1 Nipper-cut, 7".
2 Pliers, diagonal, 6".
1 Pliers, compound, side-cutting, 8".
1 File holder.
1 Spoke shave, 3".
1 File cleaner.
10 Files, assorted, with canvas roll.
1 Screwdriver, 4".
1 Palm, sewing; 8 needles, assorted; 1 ball flax and 1 ball wax.

(Lower Drawer.)

1 Stone, carborundum, 5".
1 Torch, gasoline, flat.
1 Set thin open-end wrenches with canvas roll.
1 Set drills, Morse, straight shank, with canvas roll.
1 Plane, block, 1⅝".
1 Drill, hand.
1 Wrench, 7".
3 Reamers, taper, bit stock, 1¼, 1 5-16, and 1 ⅜".
1 Hatchet, half (small).
1 Snips, tinners.

The machine should be carefully inspected, from tires to instrument board, before the start. Wires, controls, engine and gasoline and oil reservoirs are matters to be looked into by the aviator, who must not accept the word of mechanicians that everything is ready. The instruments required are a compass, wrist watch, altimeter, tachometer, inclinometer and a map board or case. The map case is highly preferable as maps pinned to a board often blow off or are torn in long fast flights.

The map is a most important part of the aviator's equipment for a cross-country flight. It should be placed in a position of easy visibility, such as on the instrument board, or, in any event, as nearly as practicable straight ahead in the line of vision. The course should be carefully mapped out and notations made, as discussed in succeeding pages. On a long journey a weather report obtained by telephone from the point of destination may save trouble should fogs or storms be prevalent there.

PHYSICAL FITNESS

The aviator should have no hesitation in informing his instructor or flight commander of any indisposition; if he does not feel well a cross country flight should not be attempted, as the correct functioning of all his faculties will be required. A long flight on an empty stomach is bad, as dizziness often results. At least a hot drink should be secured, and a good meal if possible. Food in tablet form, chocolate or biscuits may be taken along, but should be placed in a position of easy access.

MAP READING

The aviator must know how to read a map before cross-country flights can be made. An understanding of the meaning of conventional symbols and application of the scale are the main essentials, extensive knowledge not being necessary.

A typical military map is shown in Figure 100.

DEFINITIONS OF TERMS

In mapping, many terms are used, a number of which such as basin, crest, gorge, knoll, plateau, and watershed are universally familiar. A few special terms are defined here, however, for the simplification of the subject.

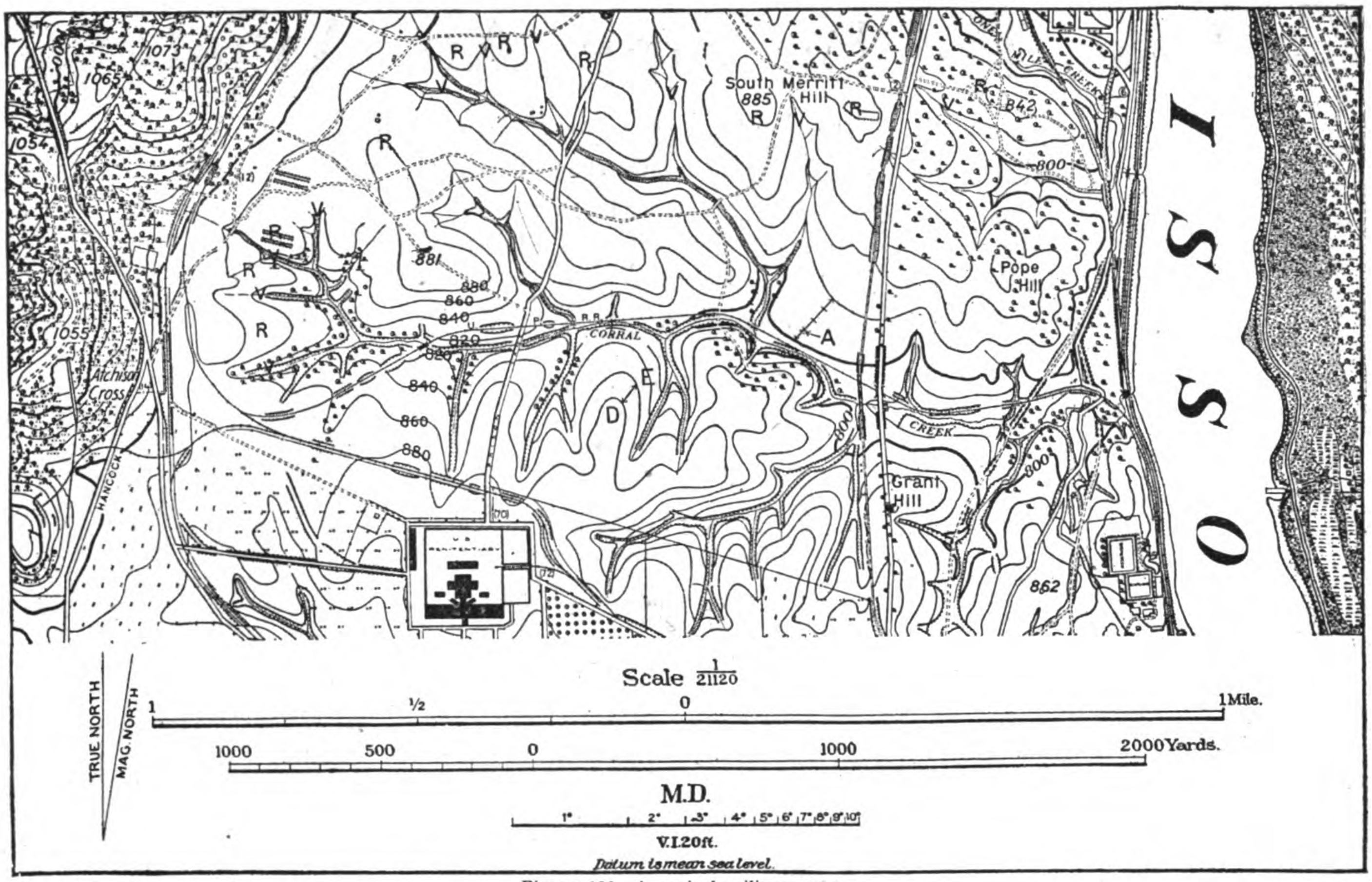


Figure 100—A typical military map

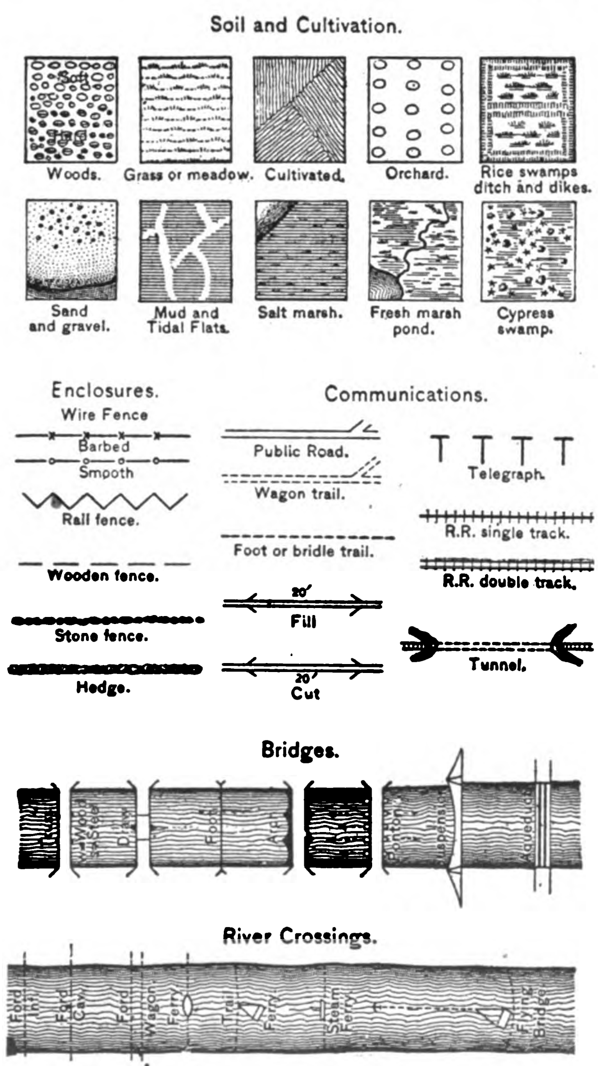


Figure 101—Conventional signs for maps

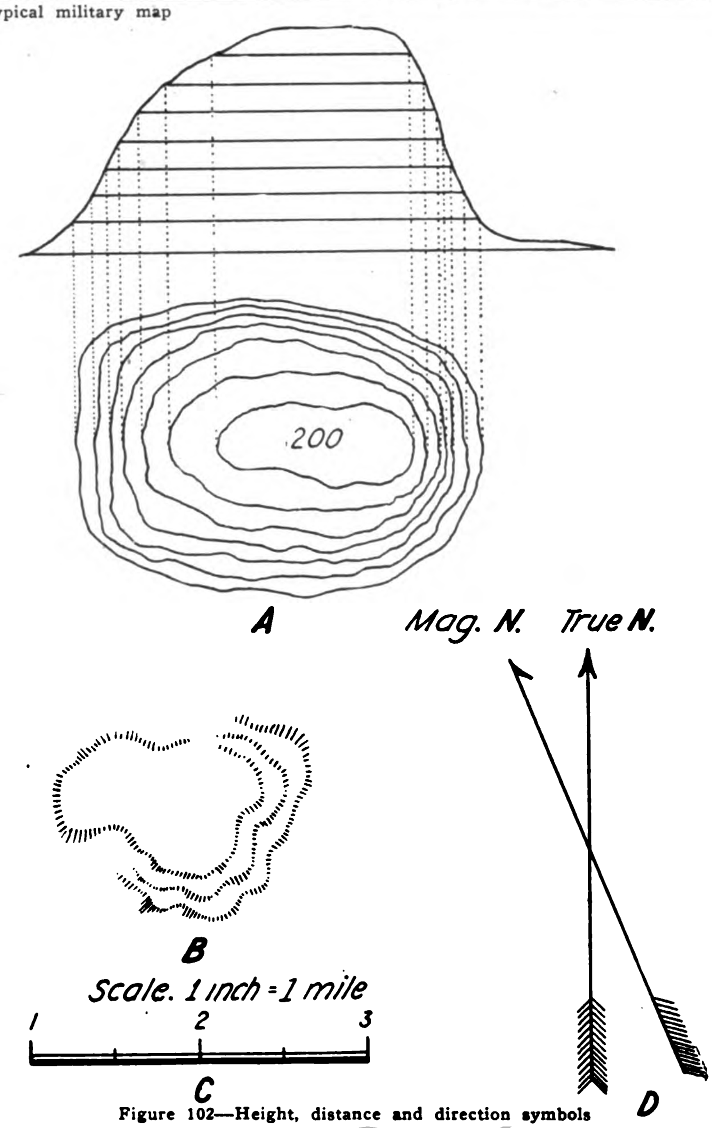


Figure 102—Height, distance and direction symbols

Bearing—The relative position or directions with the north, or true meridian; *magnetic bearing*, the relative position or direction with the magnetic north.

Contour—A line designating the shape, outline or boundary at a fixed height of a section of ground; contours are used to indicate elevations, each contour representing a rise or fall in feet from those surrounding it. Illustrated by *A*, Figure 102.

Gradient—This indicates a slope expressed as a fraction, a gradient of 1-50 designating a rise of 1 foot in 50.

Datum—A fixed level (generally sea level) from which all heights are measured.

Hachures—A shading method of representing hills, short strokes being drawn directly down the slopes. Illustrated by *B*, Figure 102.

Meridian—A true north and South line.

ORIENTING

The first thing to be determined is: Where is the north? On a map this is usually indicated by an arrow placed in one of the corners. Some maps do not have an arrow, in which case it is a generally safe assumption that the top of the map is the north. When two arrows appear, as in *D*, Figure 102, one points the true north, the other the magnetic north. Usually they are so marked, but if not lettered, the incomplete or less elaborate arrow represents the magnetic north. The magnetic north is the north of the compass; its deviation from the true north has already been explained. When the map has been turned to its proper position, i. e., the magnetic north arrow corresponding with the compass, it is said to be oriented. This is the first step for the aviator about to lay out a cross-country flight.

THE SCALE

Having located his position on the map, the next features for the aviator to study are the distances between points. These are shown by the scale, which appears usually on the lower end of the map; for example, two points are measured by ruler on the map and the distance is 1 inch; the scale reads: 1"=1 mi. (as in Figure 102), then the actual distance between these points over the ground will be found to be 1 mile. Some maps state: (so many) miles to the inch; the measuring procedure is the same, allowance being made for 2 miles to the inch, or whatever the scale states. What is known as a representative fraction is sometimes used. On the map, Figure 100, this appears as $\frac{1}{21120}$. If the R.F. is $\frac{1}{100}$ it means that an inch on the map is equal to 100 inches on the ground; the fractions are usually large, such as $\frac{1}{63,360}$, which would indictate an inch to a mile, since there are 63,360 inches to a mile. On foreign maps $\frac{1}{100,000}$ is a familiar fraction, and may indicate either inches or millimetres; in all forms the principle is the same and the scale is reckoned in the same way, afterwards being calculated in inches by the aviator. Another method of showing the scale is illustrated on the map, Figure 100, where it is only necessary to copy the scale on a strip of paper and apply the slip directly to the map, reading off the distances between any designated points.

CONTOURS

Contours on a map show the elevations, depressions, slope and shape of the ground.

Hachures (see *B*, Figure 102) sometimes used on European maps, show elevations only and are of little value. The method of indicating features by contour lines is clearly shown in the illustration *A*, Figure 102. The irregular, curving lines which appear on the map represent the outlines of the hill at equally spaced vertical intervals. If, for example, by use of a surveying instrument a line of stakes was placed around a hill, each one exactly the same height above sea level, a line drawn on the map through all the stake positions would be a contour. Study of the diagram *A*, Figure 102, will make it clear how the steepness of hillsides is determined from the map, contour lines close together indicating a steep slope, and far apart, a gentler slope.

On some maps contours are numbered in elevation in feet above the datum place, generally sea level. Thus, at a glance, the elevations are clearly determined.

CONVENTIONAL SIGNS

Interpretation of the symbols used on maps means for the aviator a quick reading of the natural and artificial features of the country. The principal conventional signs used by the U. S. Army are given in Figure 101, and should be memorized. Conventional signs are not drawn to scale on maps, but ordinarily indicate only the position of the feature.

MAP PREPARATION

The squadron headquarters prepares route and area maps in advance, so that proper maps are on hand when flight orders are issued. The work is so regulated that blank orders to pilots and observers can immediately be filled in and all papers and instructions made ready in a few minutes. Usually the headquarters personnel marks off the course for the pilot, indicates the 5 or 10 mile intervals and the "legs" of the journey. A margin for entering the various data is always left on one side of the map.

USE OF COMPASS AND ITS ADJUSTMENT

The compass is an instrument for indicating the magnetic north by a magnetized needle on a pivoted card. While cross-country flight is possible with the aid of a map and identifying landmarks, at times when these are obscured the compass is a necessity to the aviator.

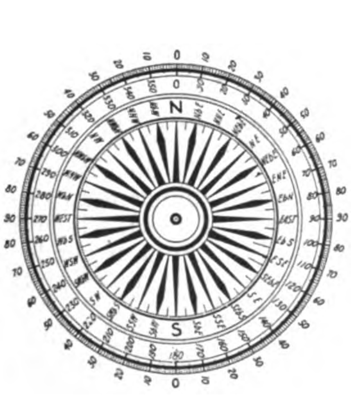


Figure 103—Compass card

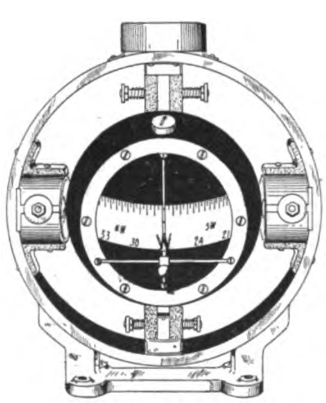


Figure 104—Vertical compass

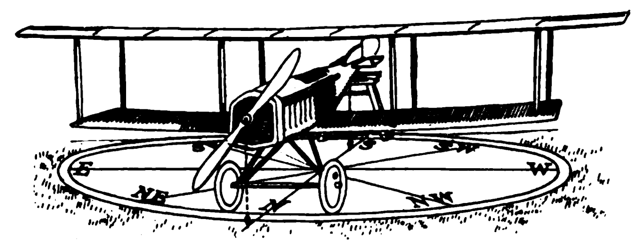


Figure 105—Adjusting the compass

Steering by compass accurately, reference to the map is not required in flight, providing preliminary calculations are accurately made as outlined further on.

THE COMPASS CARD

The card is illustrated in Figure 103. Marking in degrees is clockwise, the circle beginning at N (north) as zero, and comprising 360 degrees. The card is also marked in the old form of the merchant marine; north, east, south and west being represented by 90 degrees, bearings being read, for example, 20° W. of N. An aviation compass of the vertical type is illustrated in Figure 104.

COMPASS ERROR

Variation—The compass indicates the magnetic north from any given place; i. e., the compass magnet points to the north magnetic pole, situated on a northern island of Canada. This is not the "true" north, and it is therefore necessary on maps of the various parts of the earth to make the correction known as variation. This is the angle between the true and magnetic meridian at the point mapped.

Deviation—Since the compass needle is magnetic and the airplane contains much metal of magnetic attraction an error known as deviation is caused which deflects the needle some degrees to the east or west.

Adjusting the Compass—To correct the deviation error is a task seldom assigned to the aviator, but some idea of how it is accomplished will be found of value. (The process which we term adjusting, is known in England as "swinging" the compass.) The airplane is placed with its fore and aft axis exactly north and south, either by aligning it with a tripod "land" compass placed nearby, or by placing the airplane on a cement slab provided for the purpose in many flying fields. The airplane is trued up, in the latter case, by spirit level and plumb line, as illustrated in Figure 105. The compass has what is known as the "lubber's line," which is then fitted to the fore and aft line of the airplane. The compass reading is then taken, and by inserting small field magnets in slots provided for the purpose, the east or west deviation of the needle is corrected until it points north with the cement slab. When the best correction possible has been made a deviation card is generally made out and placed near the compass, for in long flights to a definite objective an error as small as 2 or 3 degrees will throw out the aviator's calculations. A specimen of these cards follows:

For Magnetic Course		*Steer by Compass*	*For Magnetic Course*		*Steer by Compass*
N.	0 degrees	357 degrees	S.	180 degrees	183 degrees
N. E.	45 "	47 "	S. W.	225 "	223 "
E.	90 "	90 "	W.	270 "	270 "
S. E.	135 "	137 "	N. W.	315 "	317 "

PLACING THE COMPASS

The proper location of this instrument is an important matter. It should be placed in clear view and directly in front of the pilot, preferably in the center fore and aft axis of the airplane, as far as possible from moving metal parts such as those of the engine. Metal parts such as control levers and rods, if within 2 feet of the compass, should be non-magnetic, and movable equipment such as machine guns, should be in normal flying position when the compass is adjusted. After any required change in parts is made the compass deviation should be checked and any necessary readjustment made.

A New Protective Condenser

A NOVEL condenser suitable for protection of electrical transmission lines has been designed by E. F. W. Alexanderson of radio frequency alternator fame.

The use of capacity in series with resistance between a transmission line and ground or between the conductors has been proposed for protecting the system from the effect of high frequency disturbances. With such an arrangement the protective path offers a high impedance to current of normal frequency, but a much lower impedance to any high frequency disturbances which may occur in the system. As a result, there will be a flow of high frequency energy through the resistance and a large part of this energy will be dissipated in the resistance. The power factor of a leakage circuit of this kind, however, varies widely with the frequency and with ordinary condensers is normally low. As a means of absorbing high frequency energy such a circuit is most efficient at some particular frequency which depends upon the relation between the capacity and resistance and is less efficient for frequencies higher or lower than this particular frequency.

As indicated in figure 1, Alexanderson's condenser comprises an outer electrode 1 of conductive material and an inner electrode 2 which may also be of any desired conductive material, the space between the two electrodes being filled with an insulating material 3 having a high dielectric hysteresis, such, for example, as asbestos or a compound consisting largely of asbestos. The electrodes are provided with eyes 4 and 5 for convenience in connecting the device to a transmission line. A skirt 6, of porcelain or other suitable insulating material, may be provided to prevent arcing over between the electrodes. A condenser of this type may be connected between a transmission line conductor and ground or between conductors in different phases. If desired, it may be connected between the transmission line and a secondary conductor having a high capacity to ground, so that a breakdown in the protective device will not cause a breakdown in the line insulation. A protective device of this type should be designed with small capacity so that it will have a high impedance for currents of low frequency, but much lower impedance for high frequency currents.

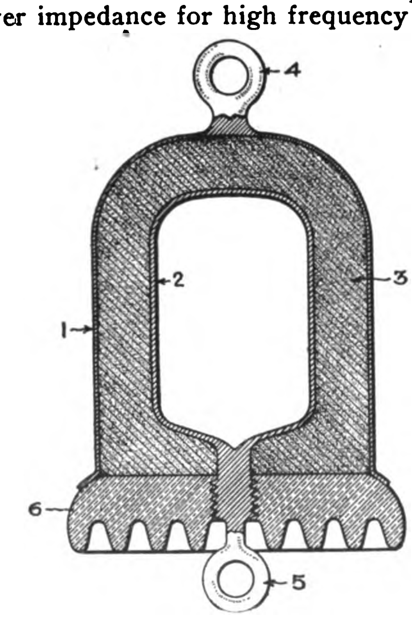


Figure 1—Condenser used to protect electrical transmission lines from the effect of high frequency disturbances

Alexanderson has discovered that the dielectric hysteresis losses of asbestos are much higher than those of materials such as glass, paper and mica, which are ordinarily used for the dielectric medium of condensers, and that these losses increase very rapidly with the frequency.

The power factor of a condenser having asbestos as a dielectric is also much higher than that of ordinary condensers. For example, the power factor of an asbestos condenser at 20,000 cycles was found to be about 38%, while the power factor of similar glass, paper and mica condensers at that frequency was 2% or less. With a frequency of 70,000 cycles, the power factor of the asbestos condenser was over 30%, and that of the paper, glass and mica condensers was about the same as at the lower frequency.

Aviation News

Atlantic Crossed in 24-Hour Flight

Though Navy Department officials said they knew nothing about it, and doubted the story, an article in the United States Naval Institute Proceedings, published in Annapolis, gives details of an alleged twenty-four-hour airplane flight across the Atlantic last July. A somewhat similar story was published in Baltimore in July, but was not credited.

The Annapolis publication says the airplane carried four passengers whose names are temporarily withheld, and that they took a number of photographs showing vessels they passed. The airplane, it says, left the Newfoundland coast at 7.02 A. M. on July 28 and flew continuously, attaining a height of 15,000 feet, for 24 hours and 10 minutes, alighting at Dingle Bay, Ireland, at 7.12 A. M., July 29.

En route the plane encountered an American troop convoy, was duly saluted by whistles and congratulated by a destroyer by wireless.

The actual line of flight was not perfect, as planned, but deviated a number of degrees southward until the destroyer was encountered several hundred miles off Ireland, when a due north course was followed for about fifty-five miles, after which the eastward course was resumed, practically along the originally planned route.

The departure was made under ideal conditions from Harbor Grace, N. F., the course being E. ½ N. true. When 170 nautical miles had been traversed, it was noon and a heavy squall caused the deviation in course.

As night came on, the flyers mounted to higher altitudes, eventually attaining 15,000 feet as a safety measure. It was blind flying at more than 660 nautical miles from land and continued thus throughout the night. The pilots alternated, sleeping and steering, and so did the mechanician and his helper.

At 4 o'clock on Monday morning, July 29, the position was satisfactory and the speed was most gratifying, the engines—12-cylinder affairs—working like a charm. Shortly before 7 o'clock the flyers "shot" the sun and found they were approximately 110 nautical miles from Sybil Head. They easily got their bearings and started on a straight course for Dingle Bay, where they touched the ground at 7.12 A. M.

* * *

Athletic Equipment for Army Aviators

An appeal for athletic equipment, and also musical instruments, for the enlisted men of our aviation forces has been issued by the National Aeronautic Committee, 289 Madison avenue, New York, of which Mrs. Newton D. Baker is honorary chairman, and Mrs. Charles A. Van Rensselaer, chairman. The committee, which is under the direction of the War Department Commission on Training Camp Activities, has received requests from officers in command of army air squadrons going overseas and also from all air training stations in this country, to supply equipment for baseball, football, soccer, basketball, track athletics, volley ball, indoor baseball, medicine balls, punching bags, boxing gloves, etc. Major General Kenly endorses this work, it is stated.

* * *

Lieut. J. A. ("Eddie") Rickenbacker Now an Ace

One of the newest of our American aces fighting with the air forces in France is Lieut. J. A. ("Eddie") Rickenbacker. Many thousands of WIRELESS AGE readers have watched Rickenbacker pilot an automobile to victory in long and hazardous races. It will be recalled that among other trophies, he won the 300-mile speedway record. With such a record behind him it was to be expected that Eddie would give a good account of himself in his new activities.

Rickenbacker enlisted in the air service early in the war and was sent across with as little delay as possible. The same reckless daring which made large crowds all over the country hold their breath when "Eddie" appeared in an automobile has characterized his air fighting. He drives an airplane as he drove an automobile, with consummate skill and an absolute disregard for the hazards involved.

One of the most famous of his encounters occurred on Memorial Day of 1918. Rickenbacker as usual drove his airplane full speed ahead over enemy territory, even when surrounded and outnumbered by enemy fighting craft. He had encountered a German Albatross at an altitude of about 5,000 feet and pursued it fearlessly across the lines. The two had already flown for a distance of three kilometers when the German received reinforcements and two other machines of the same formidable type joined in the battle. The danger of fighting above enemy territory is of course obvious. If the machine from over the line is forced to descend, even if a landing is safely made, the pilot is instantly taken prisoner with his machine.

Rickenbacker was undismayed by the superior forces. His tactics were to keep in the rear of the first enemy airplane and match its evolutions. Although facing three German flyers, Rickenbacker succeeded in outflying and outfighting the fleet arrayed against him. He brought down his man and succeeded in regaining his own lines in safety. Although the battle won the most enthusiastic praise from the French, Rickenbacker insisted that his success was merely good luck.

Int. Film Svce.

With "his hat in the ring" Eddie Rickenbacker, former auto driver and now an "ace" with Pershing's fliers, has just brought down his eighteenth Boche airplane

Under Fire With the Signal Corps

(*Continued from page* 16)

would be impossible. It has recently been rendered possible for the airplane to carry on a radio conversation with the man behind the gun.

It can be seen how great is the advantage which radio communication has over the form of communication which requires the upkeep of wires, since with the radio there are no wires to be shot away, and it requires a direct hit to put the instrument out of action. A new and interesting development is radio telegraphy through illustrates, we are told, an interesting application of science to the field of signaling.

The visual net makes elaborate use also of the old-fashioned fireworks, which have been in use in armies for years. Almost every infantryman as he goes over the top is equipped with one or more forms of fireworks, whose proper or improper use may mean for him life or death. While fireworks are used principally by the infantry and artillery men, they are trained by sol-

Signal Corps men at the battle front communicating by heliograph signals

the ground instead of through the air. This has been extensively worked out and amplified by the Americans.

The third and most extensive network of information is the visual net. The inventive genius of the French has substituted for our wig-wag and semaphore a small searchlight, resembling an automobile headlight, but with a parabolic reflector, which concentrates the rays and enables them to be directed upon one particular spot. This lamp is not only a complete system in itself, but also parallels and duplicates the telephone lines, so that in case they become inoperative they can be replaced by the lamps. It would appear to be no safer to shoot a beam from an automobile headlight into the face of the enemy than it would to get up and wave a flag at him, but the Signal Corps experts seem to have overcome this difficulty, and the way in which it has been done

diers of the Signal Corps and supplied with the right colors and selections. The number of signals which are readily distinguishable from each other under all conditions are limited, and as the enemy is constantly on the alert to pick up their meaning and duplicate them with signals of his own to confuse and mislead his opponent, it becomes necessary to change the entire fireworks code throughout the entire area. It is up to the Signal Corps to develop the code and to transmit the order to change.

The airplanes following the infantry in an advance depend upon fireworks for their communication with the various units whose progress they are watching, and it is only when the front line troops light flares, which they place upon the ground, that the airplane at night is able to determine how far they have advanced and notify their own artillery in case it might be firing on them.

The messenger net, which is a modern adaptation of the runners and mounted messengers, is the fourth means of conveying information. This net serves primarily to transmit long orders and reports, but it is so extensively developed that it may be relied upon in an emergency also to provide complete communication throughout the area. The runners operate as of old, but instead of working on the ground they are winding their way through trenches and into dugouts. A little further back mounted messengers are still employed, but they have almost wholly given way to motor cycle riders.

The feats of the American motor cycle men in France are a mystery to the French. While the French possess motor cycles, they have never made the extensive use of them which the Americans have, and consider them more of a toy than an instrument of warfare. Where the French rely upon the mail for the transmission of orders between various larger headquarters the Americans have established a motor cycle dispatch service with hours of departure and arrival as regular as train schedule in our own country. When the mail is of sufficient bulk it is carried in a side car.

Among the most trustworthy of the messengers must not be forgotten pigeons, which when released from their baskets at the front fly back to their lofts where the messages taken from the little carriers attached to their legs are transmitted to the proper destination. Dogs are frequently used in transmitting intelligence and orders in the present war. The Germans so far have been able to get better results from the use of dogs as information bearers than we have. The airplane also serves as a message carrier. It was probably due to its contemplated use in this manner that the airplane service was originally assigned to the Signal Corps.

These four nets may be developed or extended indefinitely in the future, but it is hard to see how any method of communication can be evolved that will not fit one of them. When we consider the care and patience with which these nets are installed and the amount of time required in their upkeep even in a quiet sector, the difficulties which are encountered in a large advance such as the Americans have just made can better be realized. All the nets in operation are heavily overloaded as the messages fly back and forth by the thousands. As the infantrymen go over the top, the signallers can be seen following behind them, some with fireworks, some with lamps, and some with little breast reels of wire which they lay over the ground, followed by other linemen to attach telephones wherever needed.

When the advance stops, from this flimsy skeleton the new system is built up, and finally again becomes the perfected network. But, as soon as the signaler gets his system once more in a state of perfection he moves again, and it all has to be done over.

The other activities of the Signal Corps offer opportunities for men interested in various branches of science. The meteorological department studies the atmosphere and compiles reports for commanders. These reports include information that affects the care of the troops and the maintenance of supplies, and predictions as to whether the ground will be favorable for troop movement or whether the wind will be right for a gas attack.

The listening-in service is not the least interesting activity of the Signal Corps. There is always a readiness to pick up any information of the enemy that might be of use to us. Accordingly, the Signal Corps has numerous listening-in stations which by means of devices recently perfected not only intercept any enemy radio message, but determine accurately the location of the radio instrument which transmits it. This information is, of course, at once furnished to the artillery, which proceeds to put that station out of business. Even German telephone wires have been made to divulge their secrets, though well within German territory, where it is impossible to tap their lines.

All this is accomplished by one of the most ingenious instruments which has yet been produced. By means of it our Signal Corps man can sit in his dugout on the front line with a receiver to his ear and hear any telephone message within the enemy's territory even though several thousand Huns all jabbering their lingo may intervene between him and the nearest point to the wires.

Some December Articles

A description of a rectifier using an inert gas under pressure in place of the usual vacuum in the enclosed medium.

Articles on: A Wireless Time-Signaling Device—An Incandescent Cathode Arc Used for the Rectification of Alternating Currents.

Experimenters' World

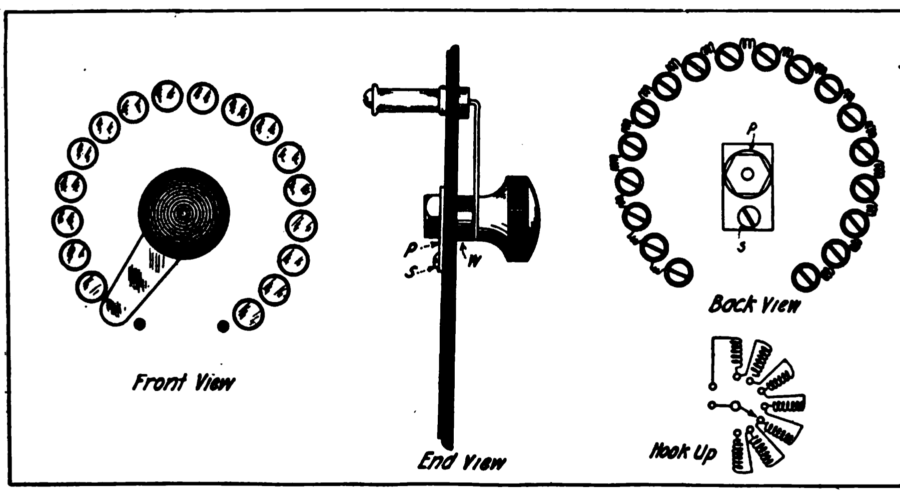
A Positive Vacuum Tube Circuit Controller

MANY of our amateurs intend to "be prepared" for the grand opening of stations when Autocracy has been wiped off the face of the earth. They are mentally designing wireless communication sets showing vast improvement over those with which they had previously been acquainted. In designing this "super-set" there is plenty of time to consider each proposed detail very carefully before incorporating it into the design, and it is very evident that this should be done, as raw materials must be conserved for war work and there must be no waste. While on the subject, it might also be suggested that any spare pieces of material, which in peace times would be considered scrap, should be utilized wherever practicable.

In designing the vacuum tube cabinet the amateur is confronted with the conventional porcelain-base rheostat, which, although it is quite acceptable for the ordinary set, would be wholly out of place in an efficient set. In the following paragraphs is described an improvement over the usual rheostat.

For the filament circuit the variable resistance need not be more than 9 ohms, and an eighteen-step variation will be sufficient when a proper circuit is used. The most important part of this controller is the resistance units; those made by the Ward-Leonard Electric Co. of Mount Vernon, N. Y., are preferable. If you order units with a resistance of ½ ohm each then you will know that each step in your controller will cut in ½ ohm resistance and you will be able to make tests for efficiency accordingly.

In most places the accompanying drawings will be found self-explanatory. Perhaps each experimenter has his own method of constructing his switches, but the type in the drawing has proven itself to be efficient and will not unloosen at a crucial moment. It consists of the usual composition knob with a machine screw through the center, over which is put the washer and switch blade; these being fastened in place by the threaded brass washer (W), which is ¼ inch in diameter. The remaining length of machine screw is then run through the carefully drilled hole in the Bakelite-Dilecto panel and a rectangular brass plate (P) put over the screw and is kept from turning by the machine screw (S) which is threaded into the panel. Next, a heavy brass hexagonal nut, ¼ inch thick, is screwed over the machine screw and is kept from turning by a small machine screw which is screwed in a hole drilled and tapped into one of the faces on the edge of the nut.



Showing construction of the positive vacuum tube circuit controller

The resistance units are composed of porcelain tubes wound with a special resistance wire and then covered with vitrified enamel, which completely eliminates oxidization. These tubes are fastened to the inside of the panel by long machine screws passing through the inside of the tubes, passing through the panel, and screwing into the brass switch contact on the other side. A flexible wire tap is placed at each end of the resistance unit. One of these (the one happening to be nearest the head of the machine screw which passes through the tube) is soldered to the head of this machine screw and then brought down to the

tap of the neighboring unit which lies nearest the panel, and so on, until all the units are connected in this manner. The best kind of wire for inside connections is rubber-covered stranded wire. All leads should be as short as possible and connections soldered in every case. The connection to the switch arm should be soldered to the brass plate (P).

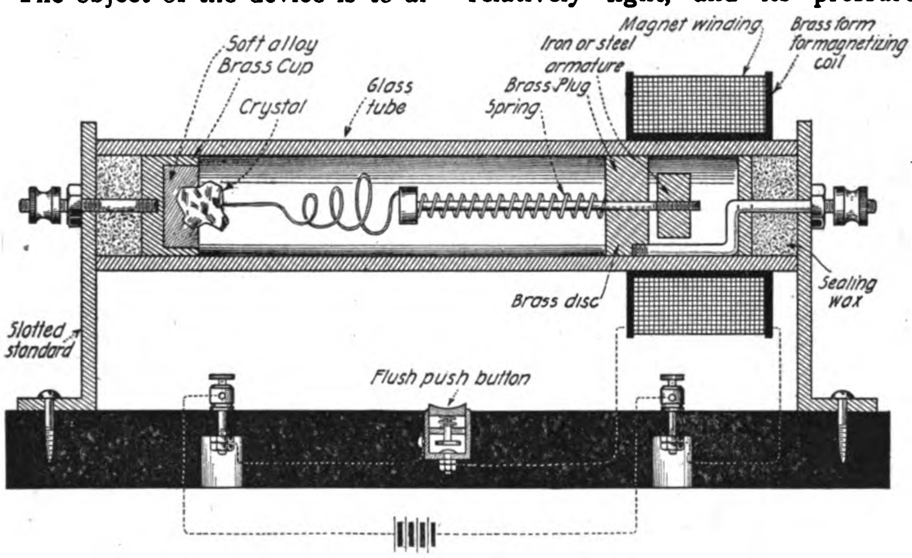
This same idea may be carried out in designing a potentiometer, but the resistance of each unit should be 500 ohms instead of the value of the rheostat units, making 9,000 ohms in all for the potentiometer. Of course the potentiometer must be connected in a different way than the rheostat. A lead must be brought from each end of the arc of switch contacts and another lead from the switch arm. If this design be used for both rheostat and potentiometer on the vacuum tube cabinet a much more uniform appearance will be obtained, due to the fact that each switch has the same outward appearance.

FRANCIS R. PRAY, *Massachusetts.*

Sealed-in Detector With Magnetic Adjustment

INASMUCH as I have never seen this idea suggested before, I venture to present it to the readers of THE WIRELESS AGE, hoping that they may be able to find some interest in the scheme.

The object of the device is to allow both the crystal and contacting means of a mineral detector to be effectually and permanently excluded from the surrounding atmosphere and its deteriorating effects; by modification of the glass container and means of bringing out the connections it may be operated in a vacuum, or even surrounded by various gasses for purposes of experimentation, still permitting the detector to be adjusted as easily as if it were exposed.



A cross sectional view showing construction of the sealed-in detector with magnetic adjustment

The design of the air-tight detector given herewith is intended to be suggestive and not conclusive, as the main idea may be adapted to any form of detector design that will suit the builders' fancy, but this one has considerable merit in its simplicity of construction and operation.

As the cross-sectional view given in the sketch renders the construction and operation quite obvious, only a few words need be added. The mineral cup and metal plug carrying the movable contact should be turned to a snug fit for the inside of the glass tube, and a bit of glue applied before inserting so that they will remain in position without additional holding means. The spring of the movable contact should be relatively light, and its pressure should be adjusted to suit the crystal used before the tube is finally sealed. The armature should be made from a piece of round iron or steel rod. These parts must work free and easy. The binding post terminals of the tube are used to support it by engaging them with two slotted sheet-metal standards fastened to the base. The form for the magnetizing coil should be made of light sheet brass or copper. It must be easily rotated and moved along the tube and may be wound with about No. 22 or No. 24 wire.

A flush push button should be mounted on the base, and connected in series with the coil and battery terminals. This button is depressed while adjusting the detector, and of course the magnetic field is present only while doing so. The magnetic field does not cause any noticeable effect on the rectifying action of the detector.

J. A. WEVER, *Maryland.*

Improved Code Practice Apparatus

In using the code practice apparatus described by the writer in the February 1918 issue of The Wireless Age, I experienced a "static" annoyance which interfered with the successful operation of this device. The trouble may have been caused by arcing of the brushes on the generator at the power station. The problem was solved by the following changes:

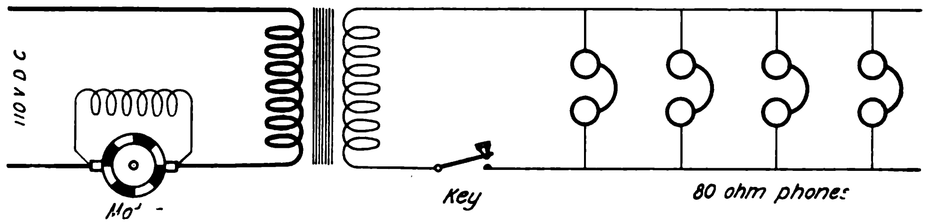


Diagram showing method of connecting the motor with induction coil

In place of the bank of lights, a small motor is connected in series with the primary of the induction coil. The secondary connections are made in the manner described in the February issue.

The accompanying diagram shows how the motor should be connected to the induction coil.

In case it is to be run without load only, a shunt motor should be used. If a small series motor is used a load must be kept on it to keep it from "building up" and finally breaking, either electrically or mechanically. If electric fans are used in the class room the motor of one of these may be connected in series with the coil.

The motor is more economical in use of current than the bank of lights and produces a much more regular sound. As a result of this a class can advance more rapidly than with the irregular type of apparatus used before.

Some radio schools have a system in which a small motor is employed to run a cast iron armature past two magnets, one of which is connected to a low potential source of current, generally a storage battery, while the other is connected to the telephones. For successful operation this type of apparatus requires that the parts be accurately machined and that they run true. The cost of all this work and material amounts to considerable in times when prices are normal, and now it would be very high.

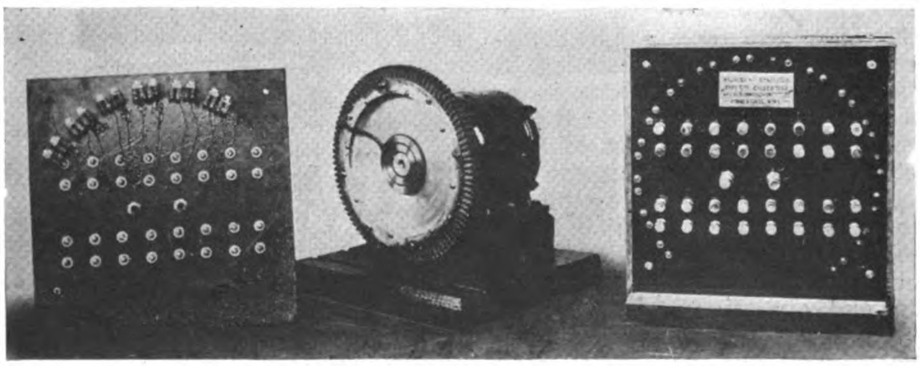
In the other system, with the motor in series with the coil, no machining is necessary, no storage battery is required, and the power from the motor may be used to run the automatic transmitter, a fan or any small device.

On the whole, this system will be found much cheaper to install and to operate and the results will be the same as the more expensive method.

Paul G. Watson, *Pennsylvania.*

Special Code Signal Generator

In the training school for radio operators at the Dunwoody Industrial Institute, Minneapolis, instead of using a buzzer for producing the practice signals in the telephones a high frequency generator is used. This generator has 98 poles and the rotor, which is the field, is revolved at a speed sufficient to give a clear musical note of about 600 cycles. The frequency as well as the strength of the signals can be easily varied so that the students get practice in receiving an exact imitation of the modern radio signals such as are obtained from undamped wave generators and quenched spark sets. The head telephones are connected directly to the stator coils of the generator through the transmitting key. It is driven by a one-sixth horsepower motor.



Generator specially designed to give exact reproduction of radio signals

The Monthly Service Bulletin of the NATIONAL WIRELESS ASSOCIATION

Founded to promote the best interests of radio communication among wireless amateurs in America

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THE call for qualified radio instructors during the past month is unprecedented. Schools scattered throughout the country, having taken the responsibility of training several hundred young men for military radio service, ran up against the proposition of locating instructors of experience to direct the training of their student allotment. The Association is, in consequence, in receipt of inquiries from more than a score of schools asking assistance.

In only a few instances have we been able to connect with men of the proper calibre. These have taken up their duties within two or three days from the time of our notification, but there still remain a number of vacancies unfilled.

There is a definite reason for the scarcity of trained radio men. The great majority of those who gained their experience in the amateur field have since gone through a course of intensified training and are now serving in the Army and the Navy. As a matter of fact, of those within draft age, the percentage remaining is almost negligible.

It would seem, however, from a broad survey of the field, that there are still some who can carry on this great work of training. Any of our members or friends who feel at all qualified to take such an appointment is urged to communicate with the Association headquarters.

The duties which Uncle Sam requires of instructors for Signal Corps classes do not in every case require the services of a radio engineer; men who have a first rate knowledge of the practical adjustment and operation of radio apparatus will fill the greater need. All must have, however, the ability to teach. In other words, an essential of instructing ability is providing inspiration to listeners, by which they are spurred on to deeper investigation of the subject in hand. Such tutors will fill the bill.

The Signal Corps does not need 100.000 radio engineers. But good, practical operators are wanted—men who can handle the key at 25 words per minute and who can take down a set, reassemble it and adjust it to its maximum efficiency. Out there in the trenches men are required who can concentrate, fellows who make quick decisions in emergencies and "get the business through."

Are any more of our readers fitted to become wireless instructors? We'd like to hear from them. They will do our country an essential service. Nothing is more important in this great war than the services of a skilled worker. And few needs are more pressing than the call for radio instructors.

The Association has discovered a humorist in its ranks. Deference to his professional standing restrains us from publishing his name,

Suggestions for the Experimenters' World

We will pay the usual prizes of $10, $5 and $3, in addition to our regular space rates, to the three contributors who send us the best manuscripts on the following subject:

WHAT IN YOUR OPINION IS THE BEST METHOD TO PURSUE TO PREVENT UNNECESSARY INTERFERENCE IN THE EVERY DAY USE OF WIRELESS TELEGRAPH APPARATUS?

This subject can be treated from both the technical and operating aspects.

Another suggestion:

AFTER THE WAR WHAT IN YOUR OPINION WILL CONSTITUTE THE IDEAL AMATEUR WIRELESS TRANSMITTER AND RECEIVER?

Limit your manuscript to 1,000 words.

but here is his plea: "I never knew until recently that my cosmic existence was so bound with electrons; and am I to assume, from the explanations that some of you scientific gents are putting forth at headquarters, that my personal atomic structure is basically electrical? Come out and be honest with we oldtimers—we want facts."

Facts!! Nothing easier, or more agreeable, we reply. We've always liked facts, and factors. Thrive on 'em, in fact. Which is a fact—absolutely. So, for fact Number One, dear sir, it should be recorded that the classification of atomic structures these days is determined by local draft boards. Moreover, with a normal congregation of atoms there will be no detectable manifestation of electrons or any other type of ethereal radiations.

It is sadly evident that you have not yet grasped the fundamentals underlying the structure of matter as agreed upon by authorities. But intelligible, so to speak, thought wave trains are occasionally permitted to emanate from the headquarters tower of erudition. Without fear of the law, therefore, you may listen in this time; and if you can—

Follow this . . . Experiment and reasoning point to the fact that a normal atom is made up of a distinct number of electrons joined to a positively charged nucleus of atomic dimensions, and a state of electrical balance thus exists which gives no external electrical manifestation.

Are you listening—carefully?

Suppose we drive an electron from an atom, what happens? The balance is destroyed. The unfortunate atom is minus an electron, and it therefore possesses an excess of positive electricity. It has been proven (over and over again) that the detached electron is negative electricity, and it is thoroughly believed that the so-called flow of an electrical current in a conductor is nothing more than the movement of electrons; that is, it is a movement of negative electricity from a negative source towards the positive terminal.

We never have positive electricity in a free state. It is always hooked up with matter in some way or an other, in so far as we know. An electron, on the other hand, can exist independently of matter or in association with atoms or molecules.

Conductors of electricity such as metals are composed of free electrons which move among the assemblage of atoms at a normally slow rate. An electric force applied to the conductor will drive these electrons from the negative to the positive direction at the normal velocity of electricity—you know, 186,000 miles per second. If the applied electromotive force is great enough, the free electrons in the conductor will collide with the atoms, and produce heat. We ordinarily call this heat production electrical resistance.

Insulators or dielectrics, on the other hand, are assumed to possess no free electrons, therefore they cannot pass the flow of current in the ordinarily accepted sense; in fact, in order to detach electrons from insulators, we must, for example, pierce them with an electrical spark. We thus tear sufficient electrons out of the structure to cause a breakdown, and ionization takes place, resulting in the phenomenon of heat and light. In plain words, electrons are imprisoned in insulators and we can only remove them by disrupting the atomic structure.

In summary: Add an electron to a normal atom and you will have a negatively charged body. Take an electron away from a normal atom and you will have a positively charged body.

It follows, therefore, dear Sir, that your existence is basically electrical. Not insofar as appearances are concerned, for you are of atomic dimensions. But if you have lived a normal life—a life made up of a vaguely defined amount of positively charged nuclei (whatever they are) surrounded by the correct number of electrons to effect a balance—you are just an ordinary everyday normal atom.

You undoubtedly possess a number of free electrons in your physical makeup. These are easily set in motion. Grasp in each hand the terminals of a 60,000-volt transformer. The ordinary slow-moving free electron which travels to and fro in your body at a rate of about 60 miles per second will suddenly rush forward at a speed of 186,000 miles per second.

Disruption of the atomic structure may ensue.

But that is science.

And though here at headquarters we greet the frankly curious many times, yet—as originally noted—we are ever eagerly inclined to standing by the facts in our statements.

Come again.

Chats With Our Contribs

Should the author of a work of fiction expose the plot of his story in the first paragraph, you would probably seek to establish contact with his intellect with an armful of bricks. You expect to twist and

tangle in a mental labyrinth of startling experiences, the outcome of which can not be conjectured by the keenest imagination. And you don't expect the climax till the last chapter—which accounts for our lady fiction fiends reading the last three pages first.

Apropos of which Assn. Hdq. wishes to officially announce that our organ, the AGE, is designed for masculine consumption; i. e., minus the "surprise" ending—and strictly non-fiction in composition. Whereas some of our contribs eternally try to surprise us with technical articles prepared a la novelist. It's a regular thing to find in the mail a technical article with the plot exposed in the last paragraph. It won't do, worthy scribes. Readers of this magazine naturally want to know, first, what your story is all about. And they're right.

It couldn't be expected, for instance, that an architect who designed a house supplied the builder first with a description and drawing of a window, then of a joist, next of a sill, then of a doorstep, and so on, without extending the faintest idea of what the final appearance of the house was going to be. The builder naturally requires first some idea of the general plan and the objects of the design.

And so it is with technical MSS. Many of our contribs hand us a long, uninteresting story of the construction of minor details, without giving the faintest idea of what the object of the apparatus is until the last paragraph is reached. This requires an extra effort to grab the verbiage bull by the horns and turn him around the other way.

What are we grumbling about? The way in which some of you fellows with basically good ideas in your craniums twist them reduces the article to the status of a Chinese puzzle for our scrutiny.

If you offer us the design of some new piece of amateur radio apparatus, it must have some particular use. All right, then state the object of it in a broad, general way. Then point out the fundamental parts of which it is composed. Next state briefly its operation and then go into the details. Follow this by a concise statement of the results secured in practice.

This is the standard form which all our contribs should follow. It doesn't mean adopting standardized forms of expression, however. We want your story to be natural, but constructed with some sense of order.

We can use a great many manuscripts on general technical subjects. Particularly articles bearing upon the construction of experimental apparatus. Descriptions of new inventions, too, accompanied by first-class photographs will be paid for at regular space rates.

You must have noticed from last month's issue that a very large majority of those in the radio fraternity are under instruction either in the Army or Navy. The figures run up into thousands. They are helping to solve one of the greatest problems the Government had to face. It was soon found that a picked set of men were required to operate complicated apparatus of modern telegraph equipment.

Men in the service cannot, of course, write for publication without permission from superior officers, but we believe that many experiences which raw recruits have undergone at these radio schools would prove of great interest to our readers. These fellows should get busy—take pen in hand, and all that. Routing the product: MSS., superior officer, us. We can handle a lot of these articles.

Queries Answered

Answers will be given in this department to questions of subscribers, covering the full range of wireless subjects, but only those which relate to the technical phases of the art and which are of general interest to readers will be published here. The subscriber's name and address must be given in all letters and only one side of the paper written on; where diagrams are necessary they must be on a separate sheet and drawn with India ink. Not more than five questions of one reader can be answered in the same issue. To receive attention these rules must be rigidly observed.

Positively no Questions Answered by Mail.

A. B. S., Cleveland, Ohio:

The speed at which a synchronous motor will run when connected to an alternator supplying current at a given frequency may be determined as follows:

$$S = \frac{2 \times f \times 60}{P}$$

when S = the revolution of the armature per minute, f = frequency of the supply current, P = number of poles in the motor field.

A ten-pole motor, for example, would run 720 revolutions per minute.

Replying to your second query, synchronous motors possess several disadvantages, among which may be mentioned that they are not adapted to variable speed; they possess a small starting torque; they require an outside exciting current and very skillful attention during operation.

Replying to your third query, the synchronous motor adjusts itself to variable loads by the change of phase difference between the armature current and the applied E. M. F. This is too comprehensive a subject to be discussed here; an explanation will be found in any textbook of alternating current engineering.

* * *

D. M. A., Washington, D. C.:

The inductance of a dynamo armature may be obtained by sending through it when at rest a measured alternating current simultaneously measuring the E. M. F. between the collector rings. The following formula then applies:

$$E = I\sqrt{R^2 + (2\pi N)^2 L^2}$$

or

$$L = \frac{1}{I^2 \pi N}\sqrt{E^2 - (IR)^2}$$

If the armature resistance R and the frequency N are known, the foregoing formula will give the desired result. Be sure and take into consideration that the value of L varies largely with the position of the armature in respect to the field poles. The reason is, of course, obvious.

* * *

H. R. T., Sydney, N. S. W.:

Your queries in regard to armature reaction in an alternator will be found answered in any text-book devoted to alternating current engineering.

When the armature current of an alternator is in phase with E.M.F., the armature reaction is negligible and the field flux therefore remains practically constant. On the other hand, a lagging armature current opposes the magnetizing action of the field coils, whereas a leading current assists the magnetization of the field poles.

Obviously an alternating current circuit of high self-inductance will tend to decrease the voltage of the alternator.

* * *

L. W. Seattle, Wash.:

A graphite rod of approximately 2,000 ohms will give the required resistance to be placed in series with your 400-ohm potentiometer.

* * *

G. C. H., Fort Stockton, Tex.:

In the wiring up of a vacuum tube panel receiving set, care should be taken to run the grid and plate circuit wires as far from one another as possible, and preferably at right angles. The two secondary terminals of the receiving transformer should be fairly well separated or otherwise they would add a shunt capacity of considerable value to the secondary circuit.

You can readily see that if the grid and plate circuit wires are placed in inductive relation, a certain amount of regenerative coupling will be obtained which may not be desirable in the circuit you have under consideration. It is not necessary to go to extremes in this matter, but it is well to take a certain amount of precaution.

We would not advise the use of an ordinary plug strap switch board for experimenting with different circuits for the reason that the parallel conductors of the plug cords possess a considerable amount of capacity between wires. This may upset the working of certain circuits.

Replying to your third query, it will not harm matters to bring the taps from the primary and secondary coils of the receiving tuner through the inside of the tube. It would be well, however, not to make them of inordinate length.

* * *

S. F. McC., Mercer, Pa.:

Ques.—(1) If a receiving set is constructed so that the inductance can be varied one turn at a time, is it ever necessary to employ a variometer?

Ans.—(1) A single turn multi-point switch will give all the regulation required. In event, however, that a single turn switch is not provided, the variometer will be found useful.

* * *

R. D. L.:

Ques.—(1) Are there any opportunities open for qualified wireless telegrapher experimenters to train students in either the Army or Navy? What are the chances of securing such employment and would a first-class amateur experience aid the applicant in securing recognition?

Ans.—(1) We believe that the amateur's experience in manipulating experimental wireless apparatus has secured just recognition on the part of the Government. A radio engineer in charge of a large Government radio school states that the students who were formerly amateurs made by far the most rapid progress. He found it rather difficult to teach men who have not had such experience to manipulate radio apparatus to secure the best results.

We are informed by the directors of the Marconi Institute that they are in receipt of numerous inquiries from colleges and universities throughout the United States for the services of radio instructors to train men in the Students' Army Training Corps. If any who have had commercial or amateur experience believe themselves qualified to carry on such work they should communicate with the editorial office of this magazine. Recommendations to the proper parties will be made.

* * *

T. D. L., Denver, Col.:

We understand that radio students at Great Lakes, Ill., after they obtain a certain ability in the International telegraph code are transferred to the classes of Harvard University. If they pass the examinations at this institution they are assigned to land stations, aviation camps or battleships. The greater proportion of assignments are made to the fleet.

In reply to your second inquiry, we understand that promotions from third-class electrician up to the appointments of chiefs are judged from the results of technical examinations given from time to time to those of proper qualifications.

A chief electrician should have a general all-around knowledge of wireless transmitters and receivers. He should be able to make elementary calculations on oscillation circuits. It is a foregone conclusion that he will have knowledge of tuning by means of a wave meter and measurement of the logarithmic decrement. Graduates of the Naval schools are expected to transmit and receive at a speed of 25 words per minute.

* * *

A. B. D., Cleveland, Ohio:

Ques.—(1) How can one enroll in the Students' Army Training Corps?

Ans.—(1) It is our understanding that if a man coming within draft age is already a pupil of a properly appointed Government training school, he will be permitted to remain and complete his course if the course he is taking is of value to the Government in prosecution of the war. On the other hand, those who are not in attendance at colleges or universities are selected according to the number of vacancies in the Students' Army Training Corps, application being made through local draft boards.

This is not official information, but it seems to be the general procedure followed in New York.

Newspaper reports have it that the Navy will open enlistments for 15,000 men per month from the various draft boards.

In reply to your third query, we believe that your knowledge of radio telegraphy will receive consideration from the Government after you have been called to service or permitted to enlist. As you will note from the draft questionnaire a thorough classification of all selected men is to be made.

Book Reviews

Above the Battle. By Capt. Vivian Drake, R. A. F. Cloth binding, 5x7½ inches, 323 pages. Appleton. Price $1.50 net.

The candidate for military aviation honors seems to have been particularly in the mind of the author while writing this book. The viewpoint is British, and the places and machines dealt with are English in substance, yet the spirit of aviation training has been caught with universality of understanding, and incidentally set down with many a whimsical touch to lend charm to semi-technical descriptive passages. When the training chapters are passed and the voyage overseas begun, the reader views the proceeding with a tinge of regret. So graphic has been Capt. Drake's descriptions of sensations in first flights that it is natural to wish for more. But equally important phases of flying are later included and described with quite as much skill. Bombing raids and night flights, artillery control, the day's work—in fact one chapter is so called—all are interestingly told in an easy conversational style. Readers who care for a little extra substance with an amiable descriptive method will be pleased with this book.

Obtainable through the Book Dept., THE WIRELESS AGE.

High Adventure. By James Norman Hall. Cloth binding, 5x7½ inches, 237 pages. Houghton Mifflin. Price $1.50 net.

Cavalry of the Clouds. By Capt. Alan Bott. Cloth binding, 5x7½ inches, 266 pages. Doubleday, Page. Price $1.50 net.

Knights of the Air. By Lieut. Bennett A. Molter. Cloth binding, 5x7½ inches, 243 pages. Appleton. Price $1.50 net.

The three books listed above are of similar type, all personal narratives and dealing broadly with military aviation in somewhat the same manner as the two narrative volumes just reviewed. In full justice to all, it must be said that they are unusually well written and leave little upon which to base a preference for the reader. In view of which, and since the main purpose of a book review is to aid readers to a decision as to whether or not they wish to secure the volume, the only real distinction must remain in subject, rather than composition.

Mr. Hall bases his incidents and anecdotes on the Lafayette Escadrille and its members.

Captain Bott glimpses the early war work of the Royal Flying Corps in France.

Lieutenant Molter does not limit himself to his unit, Escadrille N-102, but includes rather broad observations of facts and methods, with less emphasis upon experiences.

All three books obtainable through the Book Dept., THE WIRELESS AGE.

Traveling Under Orders. By Major William E. Dunn. Cloth binding, 4¼x6 inches, 80 pages. Harper. Price 50 cents net.

This volume is one of those supplementary texts for Army officers that take up the very details which govern recognition of an organization commander as a mediocre or successful leader of troops. Drill manuals and field service texts give, so to speak, only the rules of command. Major Dunn's little book takes hold of the unwritten rules which have recently been required by the problem of moving a battery from a cantonment here to the front in France. The small things that are supposedly learned only by experience are particular subjects for his discussion. This item, for example, will be greeted with a reminiscent grin by every officer who has once entrained his command: "Trucks are obtained from a quartermaster to haul the property from the camps to the train. After a certain number of trucks have been assigned to an organization, a non-commissioned officer must be detailed to remain permanently with each truck, both in going to and returning from the train. Otherwise, an organization commander will soon find his trucks busily engaged in hauling for other outfits." Equally pertinent is the warning that the train conductor and Pullman conductor check their account with that of the organization, and if a few extra vacant berths are occupied by the men for their additional comfort, a letter will eventually come from the War Department to the commander, "requesting him to explain why a charge for the same should not be deducted from his pay." Tips like these appear on nearly every page, outlining the journey by sea, arrival in France and quartering at the training camp, marching to the front, billeting and arrival on the firing line. Certain it is that an officer cannot make a better 50-cent investment than in procuring a copy of this little volume prior to departure overseas.

Obtainable through the Book Dept., THE WIRELESS AGE.

The Koehler Method of Physical Drill. By Capt. William H. Wilbur. Cloth binding, 4¼x6 inches, 149 pages. Lippincott. Price $1.00 net.

Every American knows and admires what is recognized as the West Point carriage. It is distinctive and more than ordinarily graceful—and exceedingly difficult of imitation. The reason for this is perfectly clear to the initiated, for the set of our cadets' heads and shoulders, swinging stride and easy position of arms are the direct result of a method of physical training that is quite as distinctive as the result it secures. To Major Koehler entire credit is due for this physical drill, and to application of its principles the text of the present volume is devoted. In the hands of the author, Captain Wilbur, the explanations reflect the Koehler personality which has contributed so greatly to his success. Captain Wilbur has been his assistant at West Point and special instructor at Plattsburg, and he manages to convey in the pages that running exhortation to special effort which in the Army is universally known as "boning Koehler." As an instance, in the breathing exercises we find the interpolating directions: "Fill them up! On your toes! S-t-r-e-t-c-h!! Come on!" And again, in counting: "one, two, three, four—mark, each, position, four—one, two, three, four—hold, your heads, up four," or for individual correction: "one, two—one, Brown—up on your t-o-e-s, two—one, two—one, that's right—one, two," etc.

Thus in this small volume the reader is given not only the exercises well illustrated by photographs, but clearly indicates how the instructor may make the men feel that these physical drills are helping to make their particular organization the best in the army. The advance in physical drill which marked the advent of Major Koehler's method, being perpetuated in this small volume, makes the contribution of its author of very material value in building up men physically and working them up mentally.

Obtainable through the Book Dept., THE WIRELESS AGE.

En l'air! (In the Air). By Lieut. Bert Hall. Cloth binding, 5x7½ inches, 153 pages. New Library. Price $1.65 net.

This book, which takes its title from

the command given French aviators to leave the ground on a mission, is the personal narrative of one among the first of Americans living in France to enlist at the outbreak of the war. This group, thinking a country good enough to live in was good enough to fight for, were first to the trenches with the Foreign Legion. Experiences there are briefly covered and then the balance of the book is devoted to aviation training and various episodes of war combat. Lieut. Hall's story is really an informal record of the now famous Lafayette Escadrille; the reader is introduced to the original ten American members and learns of their exploits and methods of attack.

Obtainable through the Book Dept., The Wireless Age.

Glorious Exploits of the Air. By Edgar Middleton. Cloth binding, 5x7½ inches, 256 pages. Appleton. Price $1.35 net.

By numerous anecdotes and comments on branches of the air service, Mr. Middleton has gathered into his volume a neat collection of human interest documents dealing with aviation in war time. The necessity, or supposed need, for designating the men as X, Y, or Z, instead of giving their real names is unfortunate, but in spite of this handicap the exploits in themselves are so dramatic, and in character so heroic, that the aviator stands forth as a distinct type of warrior, resourceful and agile-minded, brave and with high principles of honor. For an evening's entertainment, no better book of its kind could be found.

Obtainable through the Book Dept., The Wireless Age.

Glossary of Aviation Terms, English-French. Compiled by Capt. Victor W. Page and Lieut. Paul Montariol. Stiff boards, 5x7½ inches, 94 pages. Henley. Price $1.00 net.

This booklet does not give definitions of terms, but supplies the French equivalents for a list which is divided into four parts, namely, flying field, the plane, the engine, tools and shop. Fourteen illustrations are included, the parts of the apparatus shown in each being clearly lettered with the French term above a line under which the English designation is given. The book is intended only for use of those already familiar with aviation.

Obtainable through the Book Dept., The Wireless Age.

A French-English Military Technical Dictionary. By Col. De Witt Willcox, U. S. A. Cloth binding, 6¼x9¼ inches, 584 pages. Harper. Price $4.00 net.

Colonel Willcox's standard work appears in 1918 dress with nearly a hundred added pages to include all the new technical nomenclature of aviation and trench warfare. Even military slang and the special modern terms of the artillery and the camouflage corps appear, bringing the dictionary literally up to date. Its compiler's position as Professor of Modern Languages at West Point has given him unusual opportunities to collect the new words from reading official and standard texts. Thus for the officer about to engage in overseas service it may well prove an invaluable aid should he be assigned in time to liaison duty.

Obtainable through the Book Dept., The Wireless Age.

Fundamentals of Naval Service. By Commander Yates Stirling, U. S. N. Cloth binding, 4½x7 inches, 589 pages. Lippincott. Price $2.00 net.

Civilians in the draft who purpose arranging for induction into the Navy will find in this volume an exceptionally broad and practical explanation of the workings of all parts of naval ships and the duties of the various classes of personnel. It is a condensation in very readable form of an immense amount of official material from the Navy Department and a thoughtful abstract of the best essays on sea strategy.

Past and present naval policy is reviewed, principles of strategy given, and traditions, training, honors and distinctions explained. The evolution of the modern dreadnaught is traced and all types of battle craft described. Organization and administration of the department and a warship at sea is contained in a separate section. Seamanship, navigation, construction and ordnance lead up to a careful explanation of the multitudinous uses of electricity and the many engineering branches which comprise the naval establishment. Naval aviation is also dealt with, and the personal aspects broadened to include a survey of the navy as a career and the soldierly duties of the sailor. Even first aid and hygiene are listed among the subjects contained between the covers of this veritable "bible" of naval affairs.

It may be said without reservation that Commander Sterling has produced a notable contribution to naval literature in this handbook.

Obtainable through the Book Dept., The Wireless Age.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912.

Of The Wireless Age, published monthly at New York, N. Y., for Oct. 1, 1918.

State of New York, }
County of New York. } ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared E. J. Nally, who, having been duly sworn according to law, deposes and says that he is the President of Wireless Press, Inc., publisher of The Wireless Age, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are.

Publisher, Wireless Press, Inc., 25 Elm St., New York, N. Y.

Editor, J. Andrew White, 25 Elm St., New York, N. Y.

Managing Editor, None.

Business Manager, Alonzo Fogal, Jr., 25 Elm St., New York, N. Y.

2. That the owners are: (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent or more of the total amount of stock.)

Wireless Press, Inc., 25 Elm St., New York, N. Y.

E. J. Nally (851 shares), 233 Broadway, New York, N. Y.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

E. J. NALLY,
President.

Sworn to and subscribed before me this fifth day of October, 1918.

(Seal.) M. H. PAYNE.
(My commission expires March 30, 1920.)

December, 1918 20 Cents

The WIRELESS AGE

Volume 6 Number 3

Practical Instruction in
Aviation - Modern Wireless - Military Signaling

The Wireless Age

Edited by J. ANDREW WHITE
E. E. Bucher, Technical Editor.

Vol. 6 — Contents for December, 1918 — No. 3

Index of Equipment

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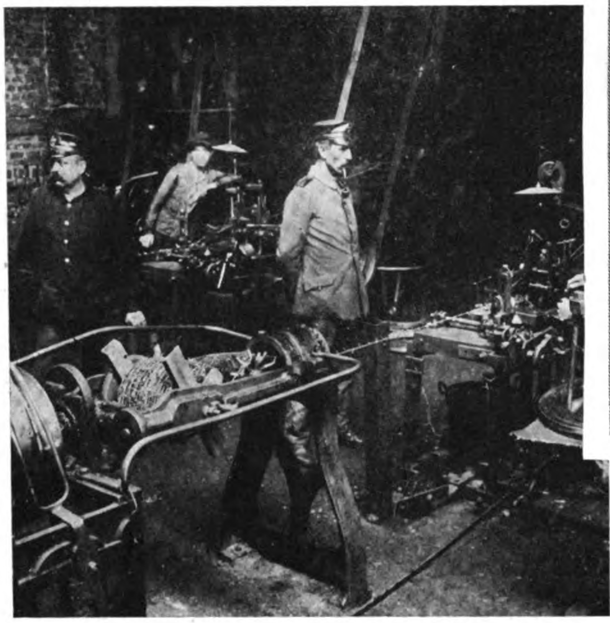
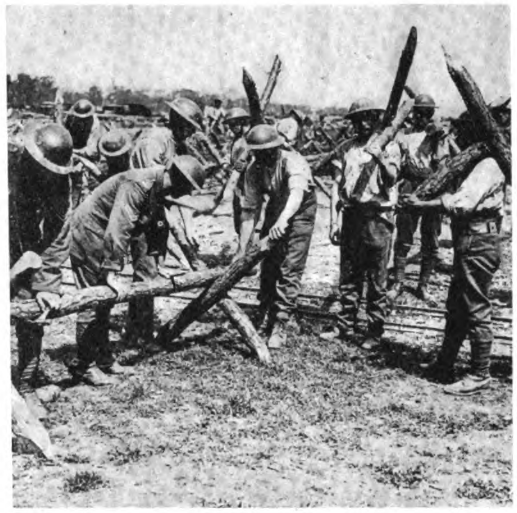
GREAT BRITAIN
Marconi House, Strand, London

AUSTRALIA
97 Clarence St., Sydney, N. S. W.

Barbed-Wire

Photos: British Official





That thousands of racks like those shown above and miles of barbed wire must be removed from France and Belgium is but one of the reconstruction problems facing the Allied armies

It is a safe assumption that shops such as shown at the left may be put to uses other than manufacturing the wire entanglements which have up to now been of so material a factor in warfare

When trees were felled to block a canal their removal by the enemy was impeded by weaving the wire through the branches

VOL. 6. NO. 3. DECEMBER, 1918

THE WIRELESS AGE

WORLD WIDE WIRELESS

Airplanes Directed By Wireless Phone

SQUADRONS of American airplanes fighting in France up to the moment of the armistice were maneuvering under the vocal orders of the squadron commander that reached each pilot by radio telephone.

News of the successful development of this device, hitherto a military secret, though some inkling of it had reached the Germans just before hostilities ceased, is now allowed to become public by John D. Ryan, director of aircraft production.

"There are some details concerning it which we cannot discuss yet," Mr. Ryan said, "but the radio devices worked out during months of experiment went into actual service some weeks ago. I have myself, standing on the ground, given orders to a squadron flying in the air and watched them maneuver accordingly. The transmission of the voice is clear enough to be heard distinctly through the sound of the airplane motor. It is in every way the most satisfactory means of communicating between planes in the air and from the ground to planes."

Mr. Ryan said he could not discuss the distances over which the radio telephone has worked, but it is known to be a matter of some miles.

W. C. Potter, of the equipment division of the bureau, explained that the idea of the radio telephone was conceived some time ago by a number of experimenters.

"For some months it has been possible in our offices in Washington to hear the airplanes flying miles over the city," he said, "talking to each other and to the ground as they worked out and perfected the device."

Loan to China Arranged by Marconi Co.

BANKERS interested in the proposed international loan to China said that the Chinese loan of £600,000 which London cables report will be offered there soon at 105 has no bearing on the Five Power Loan in which the United States probably will participate. It is merely a local loan arranged by the English Marconi Wireless Company in connection with the installation of wireless apparatus in China. The Five Power Loan still is in the diplomatic stage.

The issue arranged by the Marconi Company has been sanctioned by the British Treasury and Foreign Office, it is reported.

The Chinese Government has signed a contract with the Marconi Company for the construction of three wireless stations at Kashgar and Urumchi, in the province of Sinkiang, near the Turkestan border, and at Lan Chow Fu, capital of Kansu province, in central China.

A smaller station will be erected at Sian Fu, in Shensi province. These stations will establish communication between Kashgar and Pekin. They will be of greater transmitting power than any others in China.

Five New Stations for Philippines

THE Philippine Government has released an appropriation of $37,500 for the erection of a wireless station in Manila. Other appropriations provide for stations at Cebu, Bongao, Puerto Princess and San José, Mindoro.

Kirby in N. Y. World

"You Held Fast and We Won"

Institute Wireless for Forest Fire Emergency

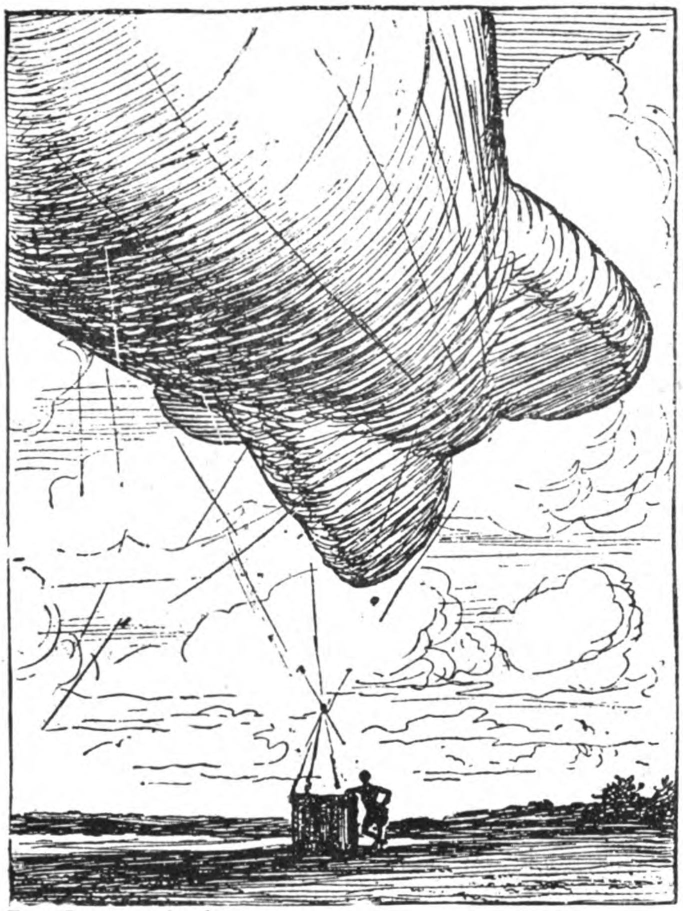
DUNWOODY INSTITUTE, Minneapolis, on October 13th, volunteered the use of its wireless plant in maintaining communication with Duluth, should other sources be broken by the forest fires. Dunwoody has the only authorized radio plant in the state, except the Government station at Duluth. It has been able to maintain the station only through the fact that naval operators have been trained at the institute.

H. W. Kavel, acting director of Dunwoody, when informed of the possibility of the loss of other sources of communication with Duluth, promptly proffered use of the station, if it be needed.

"Although we have no authority for using our plant in this kind of work," he said at the time, "loss of other communication would constitute an emergency for which, I believe, we would have no difficulty in obtaining permission to use it."

Report That Holland Contracted for German Station

LITTLE comment has been aroused by the report that Germany contracted for a wireless station in Holland less than two months ago. The radio profession is, however, extremely interested in the dispatch which was cabled to the Christian Science Monitor on October 12th announcing a Berlin message which stated that the Dutch Government concluded an agreement with the German Telefunken Gesellschaft, empowering the latter to build a wireless station at Kootwijk in Holland, of the same power as the Nauen station, to enable Holland to hold wireless communication with North and South America, and the Dutch East Indies.



From Punch (c) London

Sent in reply to the following request: "Darling, do send me a picture of yourself standing by the machine you fly in"

Enemy Submarines Radio Weather Reports

IN connection with the work of the German Army Meteorological Service, it has, since the beginning of the war, been a matter of some interest to know how the enemy obtained the observations, especially from the western coast of Ireland, which are very necessary in constructing weather maps and in making forecasts. Captured documents show that their meteorological reports were fairly complete, despite the fact that no publication of weather data or forecasts were permitted in English newspapers. An English meteorological expert declares that the answer to the question is not through any system of spies and land wireless, but that the data were obtained from observations taken by submarines. He thinks that a submarine working off the western Irish coast was detailed to send weather reports to Germany by relays through the wireless apparatus working around the British Isles.

Sites for Japanese Station Decided

ACCORDING to the Japanese department of communications, the new duplex wireless station, the construction of which this magazine predicted in the October issue, is to be built in Fukushima prefecture and will cost 860,000 yen ($430,000). The transmitting station will be at Hibarigahara, near Haria-machi, and the receiving station will be at Hosoya-cho. Survey work has been started by engineers of the department. The direct distance between the new office and San Francisco is 4,600 miles, while that between the Funabashi office and Honolulu is 3,250 miles. Service will not be opened for two years.

Ship's Radio to Report Gulf and Coast Weather

"IF VESSELS of any size at sea and plying the gulf had necessary wireless instruments so as to notify the weather bureau stations of weather conditions it would be a great benefit in forecasts," is the opinion of Meteorologist W. J. Bennett of Tampa, Fla. "Had such been the case and if war conditions permitted boats to be stationed at certain points, warnings of such disturbances as the Clearwater and west coast storm would be forecasted in time for an advisory," he adds.

"The hurricane or series of tornadoes which apparently originated in the central section of the gulf was the first storm of any intensity to occur in years of which no warnings were given. It is possible that warnings were sent to Washington of this storm but it was too late for advisories to be given out," he explains.

Mr. Bennett thinks that with the war over the Government may take some action in putting vessels with wireless equipment at such points that advices may be sent by wireless to the weather department in Washington in time for warnings.

Secret Wireless Station Helped French

SINCE the armistice brought hostilities to an end it has been learned that the morale of the population of Lille was maintained by news given from a French wireless station hidden from the Germans. Good news spread quickly through underground channels. The people knew that 10,000 American soldiers were arriving daily. Airplanes also dropped many leaflets, which were eagerly taken despite German efforts to prevent their distribution.

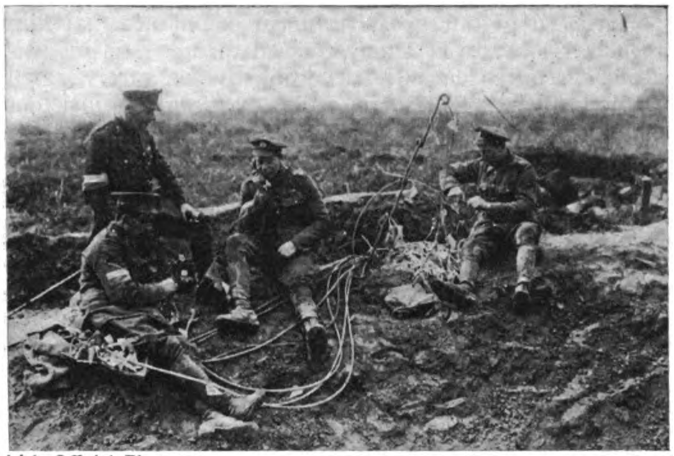
Constabulary Seize Unsealed Set

AFTER troopers of the State Constabulary had maintained a vigil three nights outside the home of Christian H. Siebs in Spring Valley, N. Y., where they discovered a wireless telegraph station, Lieut. John Walton seized the apparatus on October 17th.

Police and military authorities long have been trying to trace mysterious signals and surreptitious wireless outfits in the hills of Rockland County. Recently, through Major Ord of West Point, signallers were warned they would be shot.

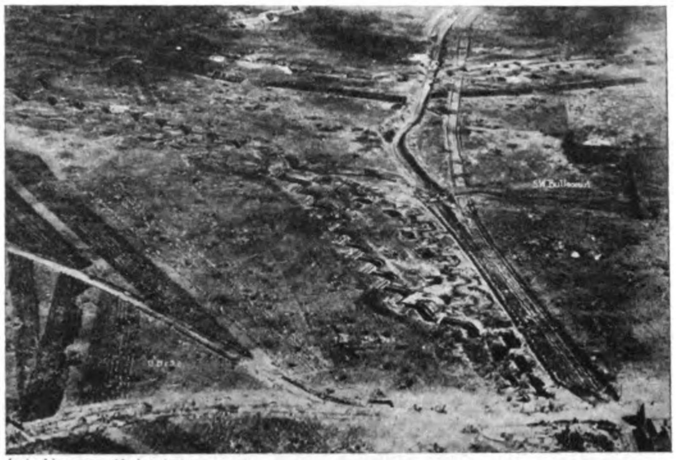
Lieut. Walton found the set dismantled but in such shape it could be very quickly set up and operated. It had never been sealed, as the Federal law requires, the police allege.

No further action will be taken, it is announced, as there was no evidence that the apparatus had been in use for several months, and that the only complaint against Siebs was that the apparatus was not sealed, as required by Federal regulations.



British Official Photo

Perfection of signaling systems using sound and light has been one of the principal achievements of American physicists



(c) Comm. Pub. Info.

A trench system like this, a view of the Hindenburg Line, became possible only through the help of the geologist

How Science Beat the Hun

The Accomplishments of the Trained Man of Science in the War *

By J. S. Ames

Professor, Johns Hopkins University

I THINK it is only fair to say that the universities of this country have played their part well. Before we actually entered this war, in those anxious years when we were waiting to see whether we would be given an opportunity to join in the fight for the cause of honor, freedom and the teachings of Christianity, or whether we must walk through the years of our lives with heads hung in disgrace, no group of people did as much to hold aloft the illuminating torch revealing the iniquity of the enemy of civilization, as did the presidents of our universities. Theirs will be the honor forever. They would not keep silent. Then, as soon as we were by official act in a state of war, the first to step forward and say "use me" were the faculties and the student bodies. It was indeed a sight which brought tears to the eyes, and even further, to see our young men, the chosen men of our land, struggle against all restraints, eager to bring to an end that evil thing which threatened to destroy all the joy of life, all that made life worth living. Every teacher has felt thrilled by the daily farewells of his students, as one by one has obtained permission, by fair means or otherwise, to enlist in the grand adventure.

It is the privilege of being a young man today, a college man or not, to be a soldier in the cause of civilization and to help bring victory to its colors; and what a glorious privilege this is! But upon whom rests the duty of interpreting events and their causes in language so clear that every man understands? Surely, upon the university man. And, when victory is won and men can give their minds to thoughts of safeguarding the world, there is no one to guide them but the students of history and of political science.

It would be a simple matter to show how a special and particular responsibility has already come to and will continue to remain with each and every university group of scholars. I can speak with more definite knowledge of the relation borne by various branches of science with the war; and it is to this feature that I shall confine myself.

A recent writer has alleged that the study of science at the expense of morals in German universities has led to this war.

This is a bitter charge, but it is supported only by fallacies. Macaulay, in his brilliant essay on Dryden, shows, by a series of striking illustrations, how little is the influence upon the age of any individual, or any special group of individuals, when compared with the influence of the age on the man or group. When the time is ripe, the idea is born; the special man who reveals it is immaterial.

So it is today, no one man, no particular department of thought or study can be held responsible for the present conditions in Europe.

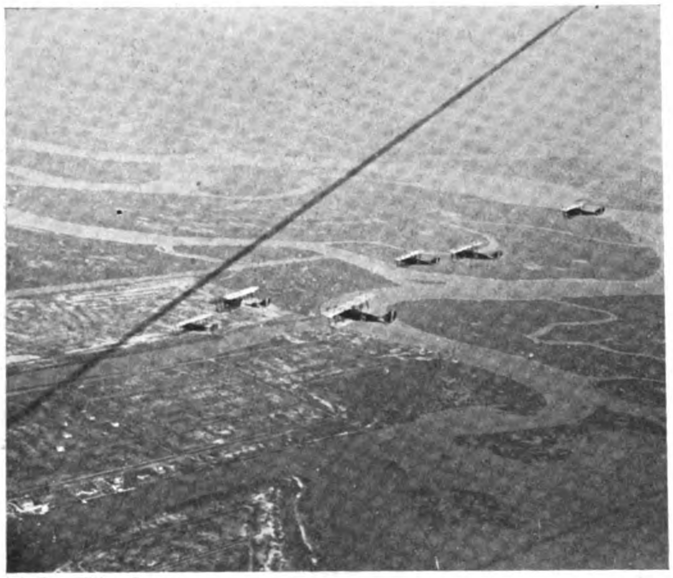
It is no more fair to say that the pursuit of science perverts character than to assert that the study of morals results in ennobling it. This war is due to a gradual debasement of character and nothing else, and the cause is to be sought in the will of the leaders of Germany.

One reason why science has been thought of as the scapegoat is because it was so evident from the very beginning of the war that Germany had mobilized for the purpose of war all her men of science, and was using the fruits of their investigations in ways entirely unexpected. This was a matter of great surprise to most Americans, and illustrates clearly the comparatively insignificant position held by scientific men in the minds of our people.

This feature of Germany's long preparation for war, and of her manner of waging it was recognized instantly; and preparations to combat it were made promptly by all the allied peoples. Fortunately for us, the essential advantages were all with the French and British, inasmuch as their men of science had for nearly a generation been the ones who had given to the world its great discoveries and their most important applications. So their scientists came to the problems with ideas and methods which in many cases far surpassed the power of Germany to equal. The result was instantaneous; and today the efficiency of the forces of the Allies on the sea, on the land and in the air is due in no small degree to the men whose previous lives had been devoted to the pursuit of the pure sciences in university laboratories.

When this country entered the war, it is true beyond any doubt that American people had great expectations, nay a conviction, that with our so-called inventive genius

* **Abstract of an Address at the University of Virginia.**



(c) Int. Film Svce.

These airplanes remind us that the so-called Liberty engine, the result of scientific investigation, has no superior in the world. It weighs but 2 pounds per horse power

we would seriously influence the war, perhaps stop it, by the epoch-making inventions which our professional, highly advertised inventors would quickly make. The newspapers helped in fostering this belief, and many were the proud boasts which we heard. There was a great disappointment, almost a shock, as the days went by, the periods promised for great accomplishment passed, and certain names almost disappeared from the public press. We have in fact stopped asking what has happened to the "wizards."

The reason is that the problem of this war is not to perfect an old device, but to design a new one; the knowledge required is not that of the amateur or even of the trained engineer, but definitely that of the scientific investigator, the man who by his own laboratory investigations has added to our store of knowledge.

One illustration of this may suffice; one government board, with whose activity I am familiar, has had submitted to it in the course of the year 16,000 projects and devices, proposed by so-called inventors; of these only five had sufficient value to deserve encouragement.

I have nothing but admiration for these 15,995 men, whose disappointment must have been keen. Most of them were more than willing to give their inventions freely to the government. The point I wish to emphasize is that the ability and knowledge required in waging this war successfully are not those possessed by any body of men except those with a profound knowledge of science and of scientific method. The problems are too complicated. It is true that with the help of trained technical men we will get better engines, better explosives, better guns; and for these we should be truly grateful to our much-boasted American genius. But, consider a problem like this: to devise a light signal, which can be used by day or by night, and which will be absolutely invisible to the enemy.

Who can solve that? The answer is obvious: only a physicist.

In times of peace, when commercial development is uppermost in men's minds, the university scholar is at a great disadvantage. He rarely knows what problem is to be solved. He is busy with his own studies and researches, and does not come in contact, in the ordinary course of life, with the demands of the technical trades. His discoveries are made use of, and are always—sooner or later—of commercial value; but in this later stage he does not take part.

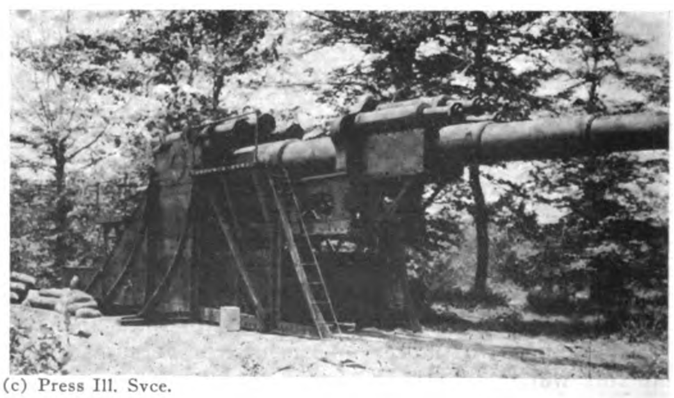
Nearly all of our great technical companies maintain extensive laboratories where trained men pursue investigations in pure science; but problems are rarely given them to solve. Today, in order to meet the insistent demands of the war, the whole process is changed. On every battlefront of Europe, attached to the various staffs, are men from university faculties, skilled in observing, quick to learn what is needed. In Paris, London and Rome there are groups of university men whose duty is to collect data from the Allied powers along similar lines. Reports containing clear statements of the problems are cabled to Washington. To this same center come requests for help from our own forces on this side of the ocean. Then, as soon as the problem can be formulated with definiteness, one or more men are asked to find the solution.

For the first time in the history of science, men who are devoting their lives to it have an immediate opportunity of proving their worth to their country. It is a wonderful moment; and the universities of this country are seizing it. The stimulus to scientific work is simply enormous; and the growth of our knowledge is astounding. In many cases investigations are prolonged for months, and in the end possibly the much desired solution is not obtained; but in any case new methods are made available for future use, new instruments are perfected, and the store of human knowledge is vastly increased.

Let me give one illustration of this reaction of the demands of war upon pure research. In the construction of a mask to be used in case of a gas-attack it is obvious that one method of defense is to make use of charcoal which is known to absorb many gases with great rapidity. A scientific problem was to try to increase the efficiency of this absorbing action; and it was soon discovered that by a special treatment of charcoal made in special sizes from special wood the absorptive power could be increased enormously.

Here is a fact of the greatest importance to the chemist, a fact which will be remembered in countless investigations of the future; and yet it is doubtful if it would have been discovered for many years to come if a particular chemist had not been asked by the military officers to help them.

My thesis is the importance of the work of the trained man of science in this war, with emphasis upon the fact that his great usefulness should not be a matter of surprise, as it is to most Americans. The best way of demonstrating this is to give a few illustrations, chosen from a wide field and not limited to the scientific work of any one country. Naturally I can refer only to those matters which have been revealed to the public; but I trust that many of them will be new. I have this confidence because so far the newspapers of this country have not believed that these questions would make what is called a "story."



(c) Press Ill. Svce.

This model of the monster 75 mm. gun illustrates how profound must be the knowledge of science which wages war successfully

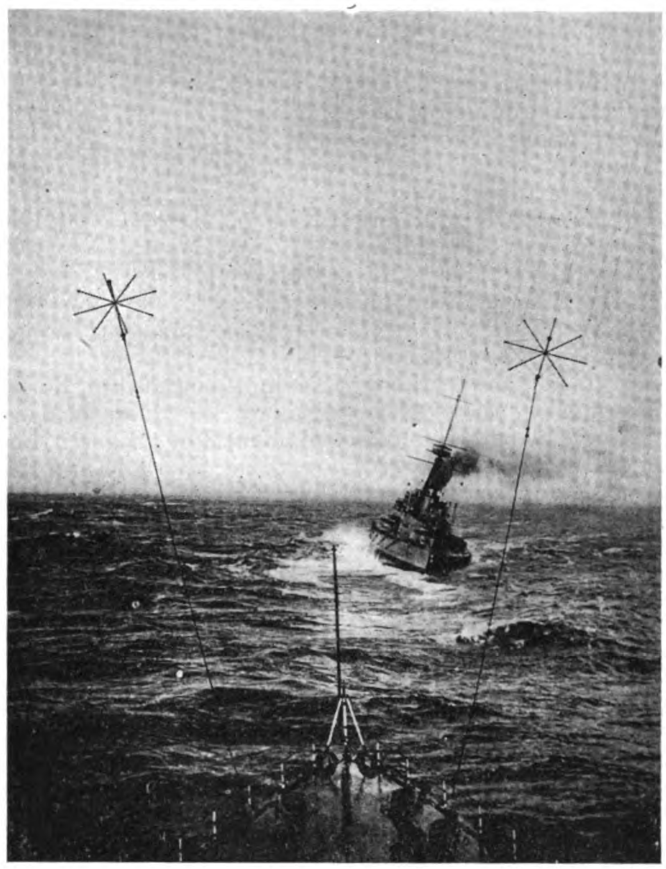
It is not easy to make a selection of the scientific problems, nor to arrange them in any logical order. There are two subjects uppermost in the minds of everyone: the airplane and the submarine. The scientific questions which have arisen in regard to each are most varied.

The airplane itself is an engineering structure; and we have confined ourselves in this country largely to the design and production of an engine. This does not really come under my general subject, but every one is so interested in it that I feel justified in referring briefly to what we have done. Our task was to produce on a great scale a powerful, efficient engine. This is now being done. The so-called Liberty 12-cylinder engine does not have its superior in the world, and further, it was so designed that it could be manufactured on an enormous scale, at least 1,500 a month. This engine has over 400 horsepower and weighs close to 800 pounds, and therefore it is useful for seaplanes, two-seater machines and bomb-droppers, but not for small machines.

When the same engine is made with 6 cylinders, developing about 220 horsepower, and weighing about 400 pounds, we will have an ideal engine, not equalled by any now in existence, for speed scout machines.

We could not have followed any plan more useful to ourselves and the Allies than to make this concentration of effort. Our eminent success is a cause of pride to every American.

With regard to the airplanes, considered apart from their engines, a few statements of fact must suffice, but they are facts. The best airplanes in service today, for each and every purpose, are those of British and French design. This is the result of real scientific investigation. The resistance offered by wings of different sections, the stability of the airplane, the character of the covering surfaces have all been investigated, and the finished product is the result of the knowledge thus acquired.



Central Photo News Svce.

This close up view of an armed cruiser's wireless aerials calls to mind the improvement in naval communication, which also may be credited to the work of trained physicists

We are doing similar scientific work in this country today, and, as we have engineers and manufacturers unsurpassed in the world, the time is not long distant when a truly American airplane will be made. We shall suffer, however, one serious detriment during the war; we are so far away that it will be extremely difficult for us to make the alterations in design which the varying conditions of modern war impose. Difficulties of transportation are great, and it is a serious question whether it would not be best for us to remove bodily our most important airplane shops directly to the Continent.

From a scientific standpoint the most important questions arising in connection with airplanes are instruments of navigation and methods of signaling to and from the ground and each other. Each machine should have for ordinary flights an instrument to indicate height above the ground, another to give the speed of flight through the air, another to tell how steep is the ascent or the descent, and many others. For long-distance flights a compass is necessary, and other instruments as well. The design of each of these is a distinct scientific problem.

Think of the requirements for a compass to be used with an airplane; for a ship on the ocean the problem is complicated, but how much more so for a vessel which turns rapidly, revolves in spirals, and which practically never keeps a constant course. In practice even more difficulties arise. The whole question of airplane instruments is still unsettled to a certain extent; many essential instruments have not as yet been designed, and improvements are needed in them all. Scientific men in all countries, including our own, have the matter under study; and the results so far accomplished are truly wonderful.

In the use of airplanes for observation purposes, or in squadron formation in making attacks, it is essential for the men in the machines to communicate with the ground. Many systems are in use, involving the application of light signals, wireless telegraph, etc. Obviously the proper instrument would be the wireless telephone, and that is surely coming, and soon it will be possible for one pilot to talk to another or with the commanding officer on the earth; and the latter can give orders to all of his machines in the air.

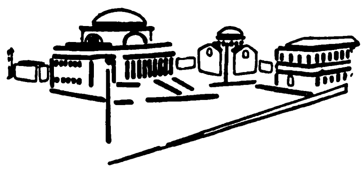
The objection to the use of all forms of wireless apparatus, telegraph or telephone, is that the enemy may confuse the signals by using the same wave-length for his disturbing impulses. This may be prevented however. Under the demands of the modern army, all forms of wireless have been so perfected that the progress made is a source of surprise and wonder. In fact there have been made in this country certain modifications and improvements which are held rigidly secret. It is interesting to note that every one of these alterations in wireless operation was first worked out in physical laboratories, by trained physicists.

Closely associated with the airplane is the balloon, either a dirigible or an observation one. The great problem here is to find a means of inflating it with some gas which is non-inflammable.

Hydrogen is now used in general; and, when a balloon is brought down in flames, it means that the hydrogen has caught on fire. This problem is partly physical and partly chemical; and numerous experiments are now in progress, all being directed by university men.

The tactics of fighting in the air are essentially unique, and before long we shall see a land-service, a sea-service and an air-service.

Progress In Radio Science



An Enclosed Rectifier

A RECTIFIER suitable for use with alternating currents over a current and voltage range comparable to the capacity of a mercury arc rectifier has been designed by G. S. Meikle.

It differs from devices employing incandescent cathodes exhausted to a lamp vacuum in that an inert gas such as argon at a considerable pressure is injected into the enclosed medium.

No very definite lower limit of pressure can be assigned; for practical operation it should be below one millimeter of mercury, for at very much lower pressures the cathode disintegrates rapidly.

The electrical characteristics of the tube shown in figure 1 are substantially those of an electric arc; and as a rectifier currents of many amperes—depending upon the size of the apparatus—can be rectified, without discharge of any current in the reverse direction. These results are obtained with a low voltage drop, which in argon is approximately 1 to 2 volts, and which varies with the temperature of the cathode, pressure of gas and other conditions.

Various inert gases may be introduced into this rectifier. Among these gases argon possesses several marked advantages. For example, an arc in argon exhibits a very low voltage drop. Under favorable conditions the difference in potential across the electrodes between which the arc is operating is only

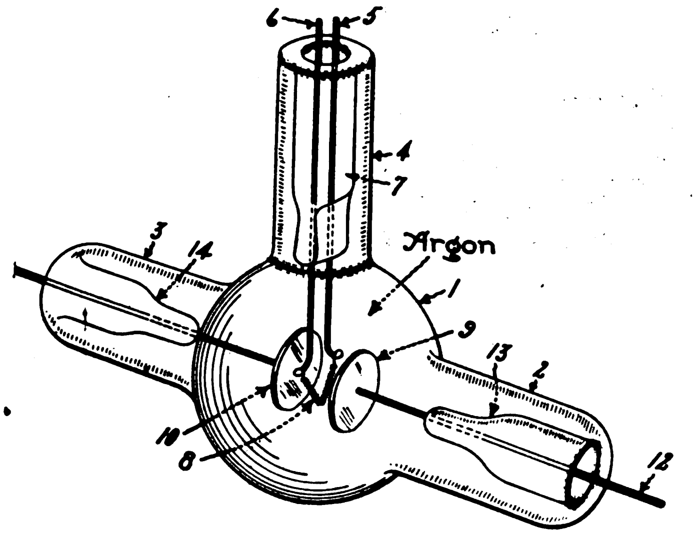


Figure 1—A full wave rectifier containing argon

about 1 to 2 volts. Argon, being gaseous at ordinary temperatures, protects the incandescent cathode from disintegration at the very start of the operation of the rectifier, whereas mercury vapor, which exhibits the next most favorable voltage consumption to argon, is condensed to the liquid state when the arc is not operating, so that some disintegration of the electrodes takes place before the mercury has become vaporized. A bulb filled with argon is also more transportable than one containing mercury.

Figure 1 illustrates a full wave rectifier containing argon; figure 2 illustrates one particular form of half wave rectifier, and figure 3 is a diagram of electrical connections.

The full wave rectifier shown in figure 1 comprises a glass envelop 1, which has three side arms 2, 3 and 4, provided for the convenience of sealing in the leading-in conductors. The cathode conductors 5, 6 may, for example, consist of tungsten sealed directly into a stem 7 of low-expansion glass, such, for example, as

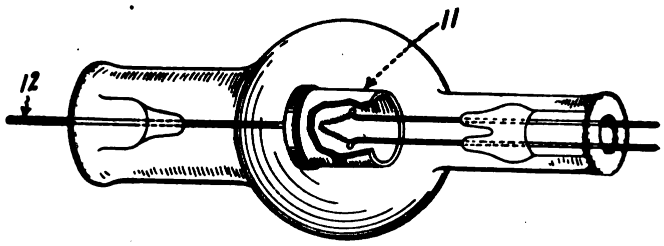


Figure 2—Illustrating one particular form of half wave rectifier

sedium-magnesium boro-silicate, although any convenient seal may be used. The cathode comprises a filament 8 of tungsten, or some other highly refractory material, operable at a temperature of about 2,000° C., at least. The cathode is heated to incandescence during operation, by a battery as indicated at 16, figure 3, or from any convenient source of current. In some cases, the heating current may be cut off after the discharge or arc is started, particularly when the gaseous atmosphere is at high pressure; enough energy will be liberated by the arc to maintain a portion of the cathode at a sufficiently high incandescence.

A clean, refractory metal, such as tungsten, at incandescence is a primary source of electrons. As indicated in the drawings, the cathode filament is conveniently coiled so as to minimize the heat losses and at the same time provide maximum surface within a given space.

The anodes 9, 10, are relatively much larger than the cathode and may have the form of disks, as shown in figure 1, or may consist of a cup, or cylinder in a half wave rectifier as shown at 11, figure 2. The anodes consist of tungsten, although any highly refractory material may be used. The tungsten anode terminals 12 may be sealed directly into stems 13, 14, of low expansion glass.

The envelop is first very carefully evacuated and baked out at as high a temperature as the glass will stand without softening, so as to remove residues of air and water vapor. Unless the anodes have been freed from gas previous to mounting—for example, by heating to a high incandescence in a vacuum—they should be freed from deleterious gases in the tube by electron bombardment, by impressing between the cathode while at incandescence and the anode to be purified a voltage high enough to cause an electron current to flow, but insufficient to produce appreciable positive ionization. Deleterious gases are thereby driven out of the anode. The evacuation may then be continued and the voltage progressively increased as gas is removed.

A quantity of argon is then introduced into the en-

velop. The gas is preferably at a pressure varying from about one centimeter of mercury pressure upward to atmospheric pressure. No definite lower limit of pressure can be assigned, but the pressure should be high enough to largely suppress electrical disintegration of the cathode by bombardment of ions.

When the gaseous pressure is low, it is necessary to

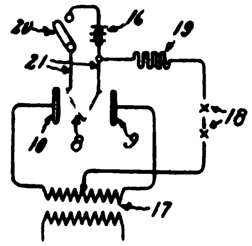


Figure 3—Diagram of electrical connections for enclosed rectifiers

provide for greater electron emission at the cathode than is necessary to convey the current; for example, by increasing the temperature of the cathode. A negative field is thereby established about the cathode; the bombardment of the cathode by positive ions and its disintegration, is reduced by the presence of these electrons, which apparently return to the cathode.

At the higher pressures the electrical disintegration, or sputtering, of the cathode is correspondingly less and the useful life of the device is correspondingly longer, so that a high electron emission is not necessary to give a long life; although, of course, a high electron emission may also be employed even at higher gas pressures. The thermal disintegration is also less at higher gas pressures. As the pressure of the gas increases beyond a certain limit, varying with the nature of the gas—which, as in the case of argon, is somewhat less than one centimeter of mercury pressure—the voltage drop in the tube increases. In most cases, however, it is desirable to operate at a gas pressure substantially above the region of minimum voltage drop in order to secure a fair life. However, when currents of low voltage are to be rectified and the highest efficiency is desired, the voltage drop permissible may make it desirable to sacrifice life to efficiency to some extent, and therefore, to operate at the pressure of minimum voltage drop. Ordinarily this is not desirable.

As shown in figure 3, the anodes 9, 10, may be connected to the terminals of a source of alternating current, such as the secondary of a transformer 17, the cathode 8 being connected to an intermediate point of potential in series with a load 18, and a series resistance 19. The device is started after suitable connections have been made by closing the switch 20 in the heating circuit 21 and heating the cathode to incandescence.

The electrical operating characteristics of the device are those of an arc; that is, an increase of current produces little appreciable instantaneous change of voltage. However, inasmuch as an increase of current will also increase the gas pressure, an increase of current is accompanied by an increase of voltage drop if sufficient time has elapsed for adjustment of pressure.

Wireless Time-Signaling Device

EDOUARD BELIN, of Paris, has developed an apparatus for synchronizing time clocks from one main radio station, permitting at predetermined intervals a correction of errors encountered in the clock mechanisms. Several methods are available for obtaining coincident effects at the transmitter and receiver, one described by M. Belin, follows:

Figure 1 shows a diagrammatic representation of the apparatus and electrical connections, while figure 1a is a view similar to figure 1 of the apparatus located at the receiving station. Figure 2 shows a sectional view of the auxiliary adjusting apparatus.

At the regulating station A a clock or chronometer 1 periodically closes a contact in the circuit of the battery 2. This circuit passes into the relay 20, causing the wires 3 to radiate electric waves and form the regulating signal; at the same time current passes through the electro-magnet 4, attracting the armature 5, which on being displaced releases a stop 6 on the main drum 7, which in turn is driven by a motor through the friction clutch 8 and runs at a speed rather greater than that corresponding to the period of the chronometer 1. Therefore, between two consecutive closings of the circuit by the chronometer, the drum 7 makes one turn.

At the receiving station, shown in figure 1a, a chronometer or clock 1′ is provided which is identical and isochronous with the chronometer 1 of station A. Its operation is also similar to that of the station A in that it releases at similar intervals by means of the electro-magnet 4′, its armature 5′ and stop 6′, and a drum 7′ driven by a motor through the friction clutch 8′. This is not the driving drum. The drum 7′ must control, and bring into synchronism with it, a drum 7″ driven through the friction clutch 8″ by means of a system comprising the electro-magnet 4″, the armature 5″ and the stop 6″, but the moment at which it can release the stop 6″ can be regulated to coincide with the moment when 4′ is operated.

For this purpose the drum 7′ is provided with a contact 9, which at each revolution strikes against a contact 10, closing the circuit of the battery 2″ through the electro-magnet 4″. In parallel with this circuit is arranged the receiver E, in such manner that the clos-

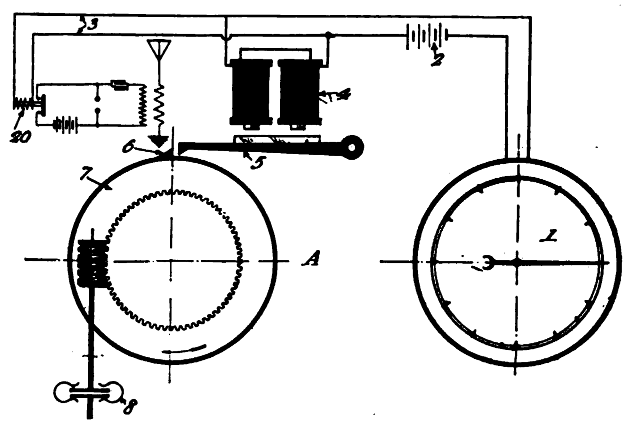


Figure 1—Diagram and electrical connections of wireless time-signaling device at the regulating station

ing of the contact can be detected. By listening, it is then possible to hear both the signal emitted by the main battery 2 and the signal by the controlling battery 2′. This in practice will hardly ever be in coincidence. All that is necessary then is to move the contact 10 by displacing it, manually through the screw 11 and the wheel 12 around the axis of rotation of the drum 7′ in such manner as to obtain an exact coincidence. At this moment the synchronism of the drum 7′ will be identical with the drum 7 which were formerly only in isochronism. The synchronism will therefore remain as long as isochronism exists between the two chronometers or the clocks 1 and 1′.

In figure 2 is a sectional view showing the method of operation of the parts 7′, 8′, 9, 10, 11 and 12. A

support 13 carries the shaft 14 of the drum 7′ driven by means of the screw or pinion 15 through the direction clutch 8′. This shaft 14 is provided at its other end with a disk 16, in which is embedded the contact

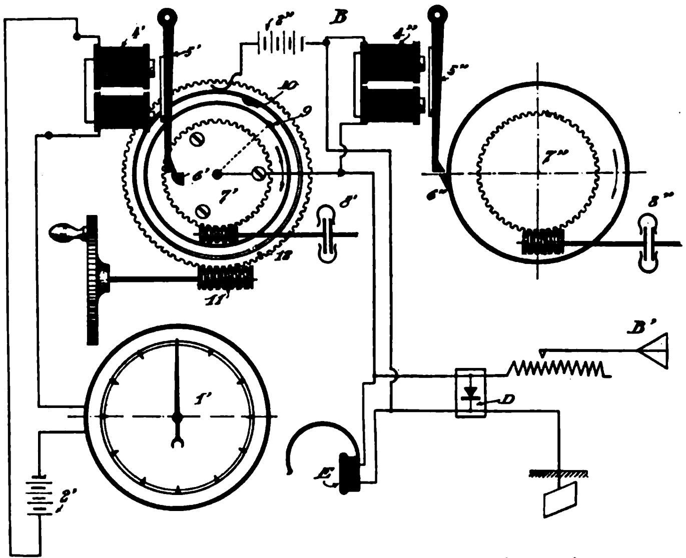


Figure 1A—Diagram of apparatus at the receiving station

9 in the form of a ball spring pressed outwardly. The shaft 14 serves as an axis and as a support to the hollow shaft 17 of the wheel 12, which carries the contact 10. The wheel 12 may be displaced by the screw 11 and consequently regulate the instant at which contact is made between 9 and 10. The electric circuit is connected to the shaft 14 and to the wheel 12. It will never be necessary to regulate the coincidence of the signals detected in the receiver E for a duration greater than that of a half period of the clock, because the wheel 12 can turn in either one direction or the

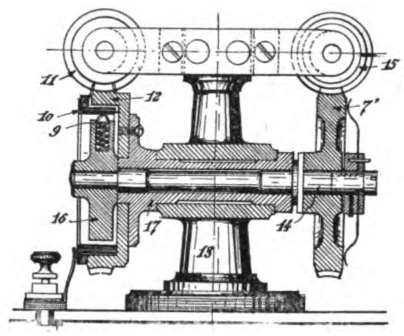


Figure 2—Sectional view of the auxiliary adjusting apparatus

other, and consequently this regulation can be made very accurately in a very short time.

The drums 7 and 7″ can be employed for very different purposes and may be connected either by wire or without, which in itself is independent of the solution of the synchronizing problem; for example, the exact time may be received by means of a series of suitable rotations occurring once every second. The signals transmitted by the one may be received by the other with great accuracy. Also synchronism may be obtained, for example, for the transmission of messages, photographs or pictures by wireless or line telegraphy, the synchronism in these latter cases being regularly regulated in a simple manner during the transmission of the other emissions.

Incandescent-Cathode Arc Device for the Rectification of Alternating Currents

In the accompanying drawings, figure 1 illustrates diagrammatically a discharge tube which may be used as a rectifier; figure 2 a modification in which the standing filament is omitted and the arc is started by means of a high-voltage discharge from a pointed cathode. Another modification having a mercury anode is shown in figure 3. These rectifying devices have been developed by Chas. V. Ferguson.

Referring to figure 1, the discharge device consists of a sealed glass or quartz envelop 1, and the cathode 2 and anode 9, both of these electrodes being sealed into the container in the usual manner and consisting of highly refractory substances, such, for example, as tungsten, tantalum or carbon. The cathode 2 consists of several parts, namely, an arcing tip 3, connected to a stem 4 having a diameter small enough to afford enough resistance to the conduction of heat to enable the arcing tip 3 to operate at incandescence. The stem 4 is connected to a current-conveying conductor 5 sealed into a stem 6. The arcing tip should be so arranged and supported that the heat lost by conduction through the supporting stem consists of such a small fraction of the total heat, developed by the cathode that the arcing tip is maintained at a uniformly high temperature by a comparatively small amount of energy. Consequently, with a given current the total voltage across the arc is lower than it would be if no section of reduced diameter was provided. This result can be conveniently obtained by reducing the diameter of a small section 7 of the supporting stem adjoining the arcing tip as shown in figures 2 and 3. In some cases the cathode has a pointed or sharpened tip (as shown in figures 2 and 3) to facilitate starting and secure greater stability of the arc.

Near the arcing tip of the cathode is the starting filament 8, consisting of refractory material such as tungsten, tantalum or carbon spirally spaced about

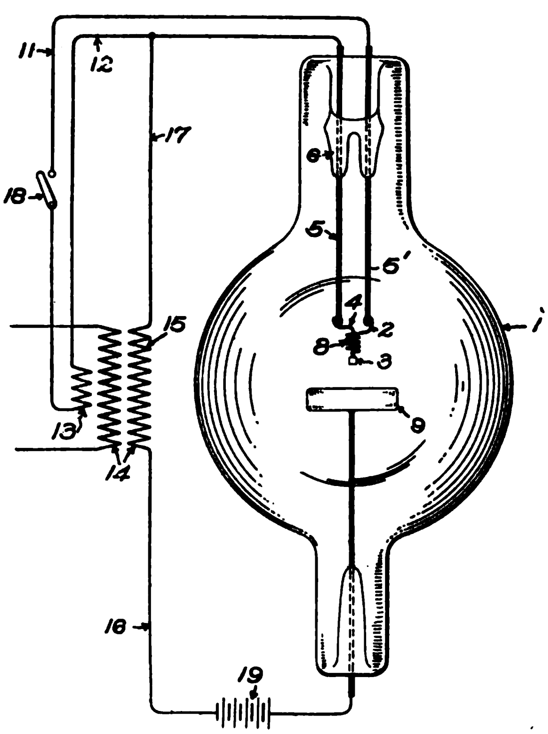


Figure 1—Diagram of a discharge tube used as a rectifier of alternating currents

the cathode stem and connected to the cathode stem 4 at one end near the tip 3 as indicated, the end remote from the arcing tip of the cathode being attached to a

(Continued on page 43)

Military Lines of Communication*

A Series on Reconstruction for American Soldiers Abroad in U. S. Army Service

By Major J. Andrew White

Chief Signal Officer, American Guard

Nineteenth Article—Aerial Line Construction

SHORT and stout poles are favored by the Signal Corps for telegraph-line construction, as these are more durable than the high poles of former days and better able to stand load strains and attacks of storms.

To avoid using a large number of aerial wires, cables are utilized whenever practicable in aerial construction, lightning arresters being always installed and telephones connected to an aerial circuit. Outside distributing wire is provided for leading from the pole to substations.

Erection of the Line

The route of the line having been decided and materials prepared, the distance is measured and stakes driven to indicate the places where the poles are to be erected. When the line is to follow highways or other defined routes, the stakes are placed so as to avoid, as far as possible, danger to the line from passing vehicles. The line is generally removed from the road a distance of about 30 feet, which insures that traffic will not be interrupted or endangered should a line become detached from insulators and hang down. The line is so placed that it can be readily examined and inspected from the road. Roads are crossed only when necessary to avoid bad ground or numerous trees, or when a material shortening of the line may be thus gained. Crossings are made at half a right angle, the distance between poles being shortened and a minimum height of 18 feet observed between wire and the crown of the road.

When the road is through rolling country, poles are planted near the crest of hills, so the wire between will be at sufficient height above the ground. Longer poles are used in hollows so the line will be graded.

In open, or unfenced country the poles are, as a general rule, set in a straight line, but wherever there is a well traveled road the line follows its general direction.

Wooden Poles

Red cedar, black locust, or chestnut are preferred woods for poles. Where these are not procurable, or the cost is too great, redwood, white cedar, red cypress, yellow cypress, tamarack, fir, larch, spruce, white or post oak and sassafras furnish timber from which good service may be expected.

Live green timber, free from rot and sound in every respect, is sought for poles. November to the end of February is the cutting time, each pole being trimmed closely and smoothly and containing the natural butt of the tree and presenting an approximate uniformly decreasing cross section from butt to top.

The table following gives the desired dimensions of wooden poles:

Length of Poles—Ft.	Circumference—Ins. At Top	Circumference—Ins. 6 ft. from bottom	Length of Poles—Ft.	Circumference—Ins. At Top	Circumference—Ins. 6 ft. from bottom
20	14	24	35	22	37
20	16	25	35	25	40
25	16	25	40	22	40
25	19	27	40	25	43
25	22	30	45	22	45
30	19	30	45	25	46
30	22	34	50	22	46
30	24	36	50	25	48

For permanent lines under ordinary conditions preservatives will be found worth the additional cost, for they not only delay the starting of decay but retard it when once it has started.

Computing the increase of life of poles by the use of preservatives requires consideration of the factors represented by the kind of wood, nature of soil, the amount of preservative and depth of impregnation; owing to these varying factors it is believed impracticable to definitely state the life increase thus obtained. Most important among these factors is the depth of impregnation and the amount of preservative per cubic foot of wood. A heavy coat on the outside is not so efficient as the same amount forced into the pores of the wood.

A line for temporary use, shown for contrast with the semi-permanent lines described

Three methods of applying preservatives are in use: (a) brush, (b) open tank, (c) pressure process. The brush method applies the preservative by a brush to the part of the pole to be treated, after it has been thoroughly cleaned. The second method immerses the pole or its butt into a tank of preservative, the solution being kept hot until the bubbling caused by air or water in the pole ceases. The hot preservative is then allowed to cool, assistance in drawing the preservative into the wood being given by the vacuum created in the timber while heating. The pressure process obtains great penetration but is seldom used on account of its cost. The brush method secures a penetration of 1/16 inch to less than ¼ inch, whereas the open tank treatment ranges from ¼ inch to ½ inch.

* For complete text on this subject see the book, "Military Signal Corps Manual," by the same author.

The part of any set pole most susceptible to decay is a section from a few inches above the ground-line to 2 or 3 feet below the ground-line.

Pine poles have a short life both above and below

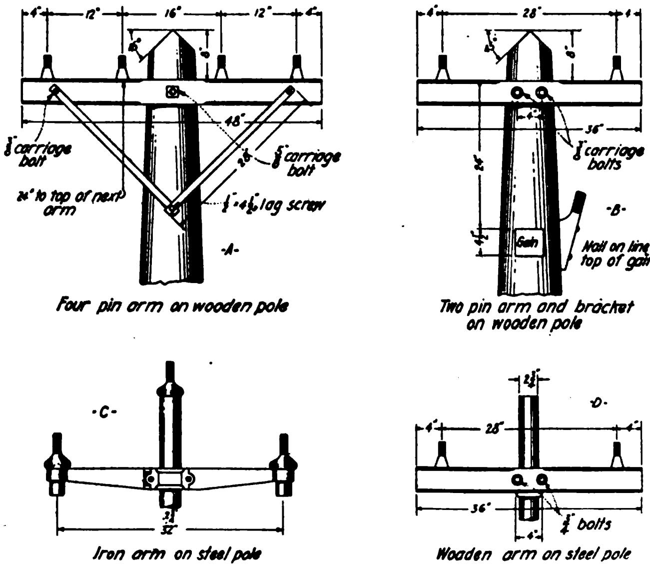


Figure 1—Method of preparing wooden and steel poles for cross arms

ground, and if this timber is used for a line in any way permanent, the entire length should be treated.

Concrete Poles

Difficulty of transportation and delivery along the route makes the use of concrete poles inadvisable for telegraph lines. For post telephone systems, however, reinforced concrete presents several advantages.

The forms are prepared by securing 3 pieces of 2-inch plank, free from knots, and dressed on one side. Top and side cleats prevent spreading when the concrete is poured through the open side, or top.

For longitudinal reinforcements, four ⅜-inch square or twisted steel bars are used for 24-foot poles, and ½-inch bars for longer poles. The four bars are set about ½ inch from each corner, being spaced by a piece of wood at each end of the form, with holes to take the ends of the rods. At four or five points the four rods are bound together by iron wire. Wooden blocks or wire hold the reinforcing rods in position at various points to prevent sagging. These are removed as the concrete is poured.

The concrete used should be a very wet mixture, 1 part cement, 2 parts sharp sand, 4 parts crushed stone of less than ½-inch size. It is important to have sharp sand. Gravel may be used in place of crushed stone, but it should be cleaned well.

The two side walls may be removed the next day after pouring, the bottom plank remaining three days longer, at which time the concrete is sufficiently set to remove it, heavy ice tongs being employed to slide it endwise. Before the concrete is entirely set the surfaces should be finished by a small amount of troweling. Concrete poles should be allowed to cure about 30 days before use.

When bolt holes and pole steps are desired, wooden pins should be placed in the form before the concrete is poured.

Concrete poles having a length of 24 feet should be about 8 x 8 inches at the base and 5 x 5 inches at the top. Beveled corners improve the appearance. The weight of a 24-foot pole is approximately 1,100 pounds, and 30-foot poles, 1,400 pounds. A 24-foot pole having an 8-inch square base and 5-inch square top requires about 7 cubic feet of concrete. Twenty-four-foot poles should be set approximately 4 feet in the ground, and 30-foot poles approximately 5 feet in the ground.

Depth of Setting Poles

Character of the soil, height of the pole and load it is to carry, determine the depth to which poles should be set. Less depth is required in rock, gravel or stiff clay than in light loam or sand. The following table gives the depths for average conditions:

Length of Pole Feet	Depth in Ground Feet	Depth in Solid Rock Feet
18	{3[1] 3½[2]}	3
20	4	3
22	4	3
25	5	3
30	5½	3½
35	6	4
40	6	4
45	6½	4½
50	7	4½

[1]On straight lines. [2]On corners.

A foreman follows with a sufficient number of men equipped with digging bars, spoon shovels, the ordinary long-handled shovels, or post-hole diggers, where the soil will admit of their use. This party digs the holes for the poles as marked out by the stakes. If there is a sod, one of the men, equipped with an ordinary spade, is sent ahead to remove it, indicating the size of the hole to be dug and facilitating the work by performing the part for which the bars and spoons are not well adapted. The foreman sees personally that the holes are put down to the proper depth, has direction of the detail and is held responsible for good service.

Setting the Poles

Holes should be dug large enough to admit the pole without the necessity of cutting away the butt, and space should be allowed to move the pole about for bringing it into line. The diameter of the hole should be great enough so the tamping bar may be used full depth.

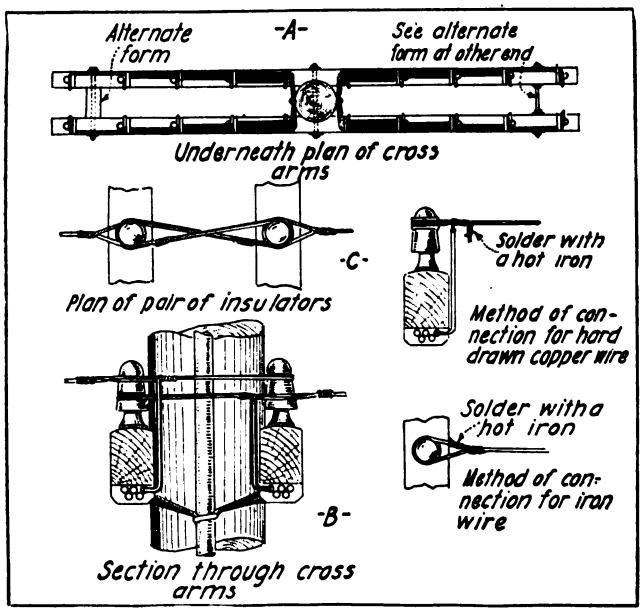


Figure 2—Double arming for aerial line construction

Thorough tamping as the hole is filled is important to the proper setting of the pole.

On straight lines, the cross arm should be placed at right angles to the direction of the pole line, the arms on adjacent poles facing in opposite directions. At line terminals the cross arms on the last two or three poles should be placed on the sides of the poles which face the terminal. The poles are set vertically.

On curves, the cross arm should be placed on the sides of the poles which face the middle of the curve. Corner poles should be given a slight rake when set, varying from 10 to 20 inches with the conditions.

After the pole has been placed in position, the hole filled, and the earth well tamped, the soil should be well

banked up about the pole and firmly packed in place; otherwise, subsequent settling of the earth will form a depression about the base of the pole. Coarse material, soil or gravel, should be used at the top of the holes. Where the poles are set in rock, the pieces should be firmly wedged in about the poles.

Wooden poles usually have more or less pronounced curves; these curves should be placed in setting so as to be least apparent when viewed from the direction of the line.

In obtaining uniform height of lead by grading the poles, differences in height of poles up to 2 feet may be taken care of by digging the holes deeper. Poles should be cut only as a last resort, and then at the top, not at the butt.

Number of Poles Per Mile

The character of the country and the number of wires or cables to be supported determines the number of poles to be provided for a line. The minimum provision is 35 poles per mile, but in timbered country, with crooked roads and heavy leads, it may be necessary to increase this number to 45 poles, or even more in special cases.

Delivery of Poles

As soon as practicable after the holes have been dug the poles should be delivered. Carrying hooks to move them as they are unloaded from trucks is the only special equipment required.

The heaviest and longest poles should be selected for crossings and long spans, the stoutest poles where angles and sharp curves occur. The butts of the poles are laid at the edge of the holes, with the tops pointing along the ground in the direction from which the raising party will come.

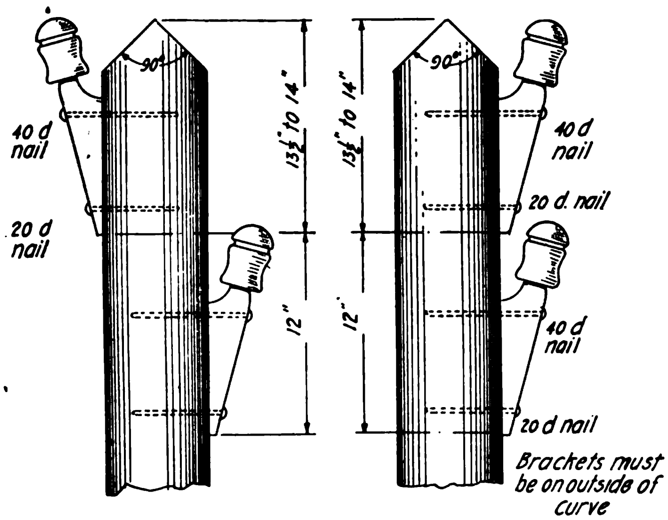


Figure 3—Method of roofing wooden poles and attaching brackets

Pole Preparation

So that the poles will effectively shed rain and snow, the tops are roofed by cutting each side to a peak at an angle of 45 degrees, as shown in figure 1.

Cutting poles when the sap is down, removing the bark and allowing them to season, increases durability and facilitates transportation and erection.

Lightning Rods

Sometimes, every fifth to tenth pole of an aerial line is provided with a lightning rod. The rods ordinarily consist of a piece of number 6 galvanized iron wire, extending not less than 1 foot above the roof of the pole and attached to its sides by means of staples placed about 1 foot apart. Lightning rods should extend continuously down the entire length of the pole, and are usually soldered to a ground rod driven into the earth near the base of the pole. An alternative method provides for their ending in a small coil of wire at the base of the pole which gives a good surface contact with the earth. This wire should be kept as straight as possible without turns or coils in its length and should be attached before the pole is erected.

In this illustration may be seen the roofing of the top, method of placing brackets and erection of the pole so as to avoid danger to the line from passing vehicles on the highway

Cross Arms

The Signal Corps specifies the following dimensions for standard cross arms which it supplies:

Length in Feet	Number of Pins	Pin Spacing—Inches Ends	Sides	Centers
3	2	4	..	28
4	4	4	12	16
6	6	4	12	16
8	8	4	12	16
10	10	4	12	16

Framing Poles

The following directions cover the method of framing poles which support cross arms:

The pole should be raised at the top and placed in a framing buck or horse so that the heaviest sag or curve will be nearest the ground. If the pole is crooked or badly shaped, it should be turned with a cant hook until the best side for framing is uppermost. With the pole then held rigidly in place it is roofed, after which the gains should be cut, leveling them with a straightedge or sighting stick.

Before holes are bored for the cross arm bolts, a line should be set off from the center of the pole's top to its butt, and the bolt hole center laid off along this line.

Half-inch holes for steps should be bored at right angles to the line, or in line with the cross arms, beginning 18 inches from the lowest cross arm and continuing to a point 8 feet from the ground, spaced 18 inches apart, or 36 inches apart when measured on the same side of the pole.

Cross arms carrying four or more wires must be braced. Figure 1 shows the method. Gains for cross arms have a maximum depth of 1¼ inches.

A distance of 8 inches is allowed between the extreme top of the pole and the upper side of the top gain. The distance to be observed between centers of gains is 2 feet. Cross arm braces should be attached to the face of the pole and to the face of the arm. Cross arms which are not braced require two lag bolts. Except where special conditions require otherwise, cross arms must be placed on opposite sides of alternate poles.

Cross arms should be set at right angles to the pole length. This applies as well to corner poles, no matter what the degree of rake.

Cross arm fixtures should, if practicable, be attached to buildings (other than residences) with bolts passing through the wall. If this is not practicable, large expansion bolts should be used. Window casements or woodwork of buildings should never be used for resisting the strain of the line.

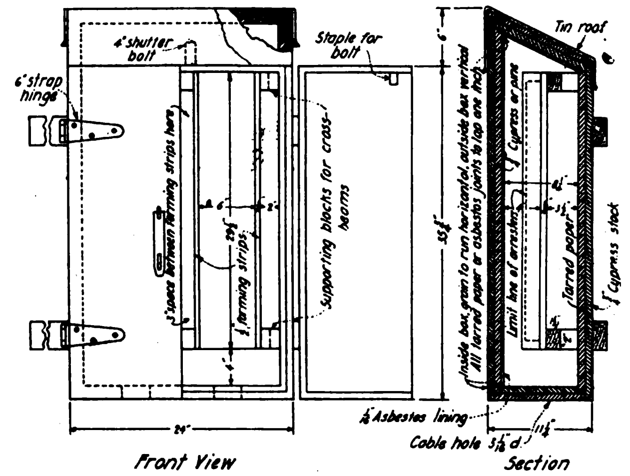


Figure 4—Construction details of cable box for terminal or office pole

Telephone line wires terminating at residences are provided with either outside distributing or outside twisted pair wire connections, the line wire being terminated at the cross arm or bracket at the nearest pole and the service completed by means of the outside distributing or outside twisted pair wire. A bracket or other type of fixture makes the wire fast to the residence, entrance being made through two porcelain tubes, each conductor of the duplex wire entering through one of these tubes. The tubes should be slanted downward toward the outside of the building so water will not enter them in stormy weather. If this is not practicable the same result will be secured by having the wires outside sag below the tubes. Wires thus arranged are termed "drip loops."

Wherever practicable, arms are placed on poles before they are erected.

Methods for attaching cross arms for leads not exceeding four wires are shown in figure 1: (a) illustrates the attachment of the four-pin cross arm with braces; (b) the two-pin cross arm attached with lag bolts; (c) and (d) show two methods of attachment to steel poles. These steel poles are only used occasionally to meet special conditions; they are not suitable for supporting more than four wires and should be installed only in hard earth or concrete.

Double Arms—The approved method of installing double cross arms is shown in figure 2. The heaviest poles available should be selected for double arm construction as these require extra strength for the additional load. Figure 2 also shows the method of dead ending wires on double cross arms. Where wires pass through they are tied to both insulators, in the lower groove of the glass if double-grooved glasses are in place.

Porcelain-coated bridle rings may be used for supporting bridle wire, instead of cleats as shown in figure 2, and copper connectors may be used for splicing bridle wire to hard-drawn copper line wire, instead of as shown in the same figure.

Bracket Lines

Where not more than two wires are required on a pole line, oak brackets may be used in place of cross arms. General arrangements are shown in figure 3, brackets being attached to the pole with one 40d nail above and one 20d nail below. So that the poles on which brackets are placed may later be used to support cross arms, the top end of the brackets should be about level with the correct location of the top of the gain, so that the bracket and its wire will not interfere with the subsequent use of the cross arm.

Terminal or Office Pole

The terminal or office pole of a line carrying a number of wires is the most important part of the line and demands careful attention to secure construction that will be serviceable and easy to maintain. Frequent access to this pole being necessary, all wiring should be substantial in character and arranged to facilitate repairs and extensions. Typical construction of an office or terminal pole is shown in figure 5. This illustration shows the method which is to be followed as far as practicable, although it is not likely that in any construction work taken up it can be exactly duplicated.

This figure shows a can terminal installed; a cable box, shown in figure 4, may be used in its place and, in fact, is considered preferable except in the tropics. In ordering cable boxes the number of pairs to be accommodated should be stated, as well as the number of pairs of lightning arresters and fuses. No aerial line should be cross-connected at a terminal pole or to a central ex-

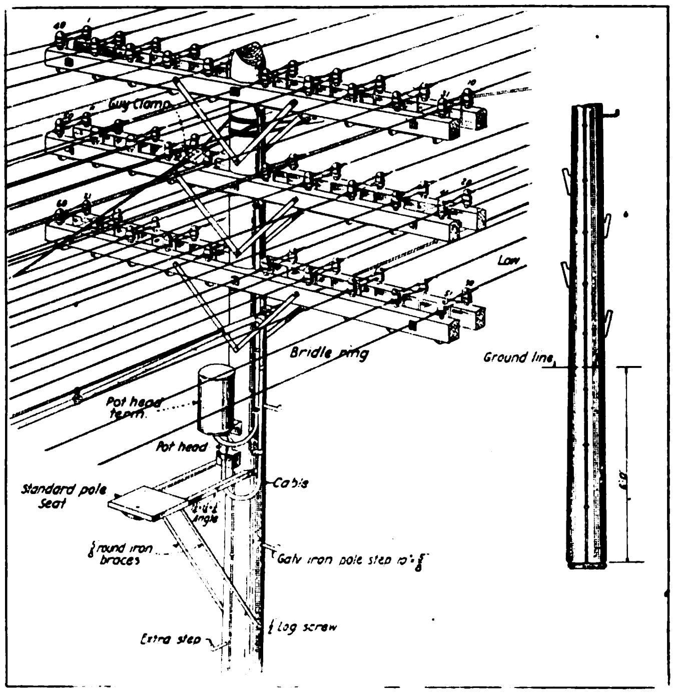


Figure 5—A typical terminal pole; Figure 6—Pole steps

change except through fuses and lightning arresters. The terminal or cable-box poles should be stepped, using galvanized iron pole steps as shown in figure 5. The lowest of these steps should be at least 8 feet from the ground. To reach these steps ladders are used, or brackets, as shown in figure 6.

Bridle wires, which are used to connect the line wires with the can terminal or cable box, run through hardwood cleats, are shown in figure 2. Particular attention should be given to all wiring about the pole to see that it fits neatly and is so placed that it will not be injured by the workman in the performance of his duties.

Where the wires which dead end on a double arm lead from one direction only, it is necessary to counterbalance the strain by running a small guy from this cross arm to the next pole.

Where poles are provided with steps, linemen should not use climbers, unless of course, such use is clearly unavoidable.

Static and Interference Eliminated

The Achievement of Roy A. Weagant

ROY A. WEAGANT, chief engineer of the Marconi Wireless Telegraph Company of America, has perfected an invention which has taken the "static" out of wireless telegraphy, thereby removing the greatest obstacle to the clear transmission of radio messages.

The invention prevents "by a selective system" the interference or crossing of one wireless message with another, regardless of the operation of any number of high-power stations, and it reduces the amount of power heretofore required to operate a wireless station by about one-half, making possible a saving of 50 per cent. in fuel. The following official announcement of the invention is made for the company by Edward J. Nally, vice-president and general manager of the Marconi Company:

With the conditions that pledged us to absolute secrecy no longer prevailing, the Marconi Wireless Telegraph Company of America is permitted to announce a discovery and invention in wireless telegraphy that will mark a new era in world communication. It is America's contribution to science in solving a problem that has engaged the best scientific minds of the world.

Ever since the genius of Marconi made wireless telegraphy a fact, the only limitation of this method of communication was the deadly phenomena of "static conditions." It was "static"—the presence of a large amount of uncontrolled electricity in the air—that at the beginning of the war often entirely prostrated the wireless service even between the most powerful stations erected in Europe and America. Static conditions were responsible for abnormal delays and for the mutilation of words in wireless messages.

It was the one great obstacle to continuous communication by means of electro-magnetic waves in the air. So baffling was the problem that Marconi issued a personal appeal to every wireless operator in the world to record his observations and to collect data on the subject. Some of the leading scientific minds in the universe struggled to overcome the effects of the static disturbances. Worldwide researches were instituted and large sums of money expended, but the end sought was not obtained.

It remained for an American radio expert, Roy A. Weagant, chief engineer of the Marconi Wireless Telegraph Company of America, to discover the solution of the static problem. Weagant practically had devoted his life to a study of this perplexing phenomena, and the result of fifteen years of experimental work was about to be published to the world, when the United States entered the Great War.

Although patent applications had been made and the claims allowed by the United States Patent Office, the Weagant system was immediately placed at the disposal of the American Government, and every precaution was taken to keep the invention secret until the discovery could be safely announced. With the spirit of research that has made the Navy such a magnificent arm of our military service, officials of the Navy Department assigned naval experts to co-operate with the inventor in installing experimental stations in various parts of the country. These stations are now receiving messages from all the high power wireless stations of the world.

With the consent of the Marconi Company, the United States Navy Department disclosed the Weagant invention to our Allies, and special representatives of the French and British Governments were sent here to study the system.

Among the revolutionary changes that the new system effects in wireless installations will be the immediate disappearance of the huge steel towers heretofore built at great height to catch the incoming wireless waves. Equipped with the Weagant invention, the wireless receiving antennae are stretched merely a few feet above the ground.

Heretofore, also, the increasing number of high power stations that were being erected in every part of the world raised the difficult question of "interference." Crossing wireless messages that shot through the ether sometimes made the wireless signals so indistinct that they could not be understood, or drowned the weaker transmission entirely. The Weagant system, based on a unique selective principle, eliminates "interference" and permits absolutely clear communication, regardless of the operation of other stations even in the immediate vicinity.

The notable contribution to wireless telegraphy opened by Mr. Weagant's discovery makes continuous wireless communication over the oceans and between continents an absolutely assured fact for twenty-four hours of the day and at every season of the year, regardless of atmospheric conditions. All the Marconi high power stations are being equipped with the Weagant system, and the stations of the Pan-American Wireless Telegraph and Telephone Company, which are to link North and South America in a closer bond of brotherhood, will likewise be so equipped. In all probability the United States, as well as the Allied Governments, will adopt this system.

Mr. Weagant, who has been a distinguished radio engineer for fifteen years, is only 37 years old. He is a graduate of McGill University in Canada and a Fellow of the Institute of Radio Engineers.

Mr. Weagant was born March 29, 1881, at Morrisburg, Ont. His father, William Weagant, the inventor of various mechanical devices, died when he was a baby, and his mother shortly after married T. J. Flint, a druggist, of Derby Line, Vt. The boy spent most of his school days behind the drug store counter. He attended the village school and later the preparatory school and college at Stanstead, Que. His interest in mechanics began when he was five years old, and he was encouraged by Dr. M. L. Baxter, a retired physician of Washington, who taught him about electricity and loaned him scientific books.

Radio Frequency Changers

Reported Progress in Their Application to Wireless Telegraphic and Telephonic Communication

By E. E. Bucher

Director of Instruction, Marconi Institute

(Continued from the November, 1918, issue of THE WIRELESS AGE)

Control of Antenna Currents

A PROBLEM of considerable magnitude is encountered in controlling the energy output of a high-power radio station so that rapid signalling can be effected. It is a relatively simple matter to interrupt the primary circuits of a low-power spark transmitter, but when several hundred kw. of energy is involved, very special means must be provided to permit the breaking of the current without undue arcing or lag.

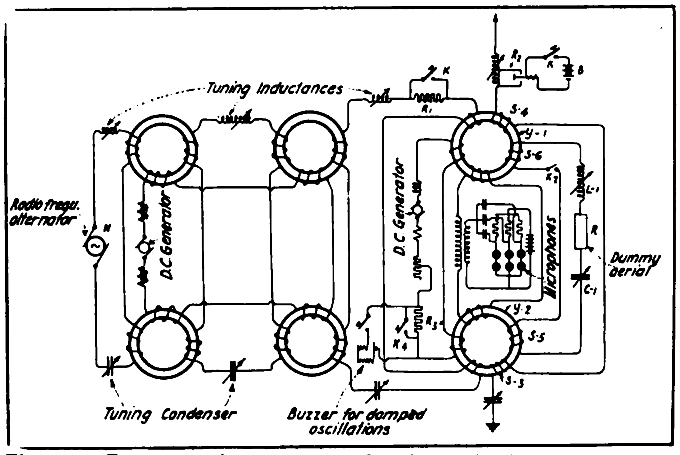


Figure 9—Frequency changer system for the production of damped or undamped oscillations with the complete circuits for wireless telephony

Marconi gave a satisfactory solution for high-power rotary spark transmitters when he devised his battery of special electro-magnetic keys to interrupt the high voltage current at points between the secondary of the transformer and the high-voltage condenser.

It has been customary in the arc radio system to effect signalling by changing the length of the radiated wave, but a disadvantage arises in this method that the antenna radiates two waves, one of which may cause interference to the operation of other stations.

Von Arco and Meissner have devised several interesting methods for controlling the antenna current for radiotelegraphy and telephony, which, in general, do not involve duplex radiation. They have shown as in the figure 9 the complete circuits of a radio system serviceable for telegraphic signalling by means of undamped oscillations, for the production of speech variations of the antenna current for telephony, and for the production of groups of damped oscillations, all from the same source of energy—a high frequency alternator.

In regard to the circuits for telegraphic signalling shown in this figure, a telegraph key operates a solenoid relay R_1 fitted with contacts which tune and detune the antenna circuit. The advantage of the frequency changer systems over the arc method is that, when the antenna is thrown out of resonance, no radiation takes place, for then no energy is withdrawn from the alternator N. However, the inventors observed that in controlling the antenna current in this way, the resulting shift of phase between voltage and current caused a dangerous rise of potential in the high frequency generator. To prevent this they placed a resistance R_1 in series with the primary circuit of the last group of the radio frequency changers, shunted by the key K′ which operates in conjunction with key K so that the signal is produced by tuning the antenna and short-circuiting the resistance R_1 simultaneously.

Controlling the antenna current in this way brought forth another problem, viz: the unloading of the generator N each time the antenna is detuned by the key K, causing the speed to vary, throwing it out of resonance with the complete system, with a consequent decrease of output. The well-known method of loading the generator by a special non-radiating circuit is then suggested so that when the antenna is not radiating the shunt resonant circuit takes the load, keeping the speed of the generator nearly constant. Practical circuits will be shown in the diagrams to follow.

In previous systems based upon this principle, it is necessary to interrupt the antenna circuit and the auxiliary loading circuit each time a telegraphic signal is made and in case large amounts of energy are involved, it is difficult to devise a signalling key that will operate satisfactorily. However, Arco and Meissner have shown a system of connections by which the antenna remains permanently connected to the source of high frequency current and the transference of the load from the antenna circuit to the auxiliary loading circuit and *vice versa* is obtained simply by variation of the tuning of the two circuits. The circuit is shown in figure 10 where two magentic relays R-1 and R-2 are connected so that their contacts shunt the antenna loading inductance L-1 and the auxiliary load inductance L-2 alternately, signalling being effected by closing key K. The secondary windings S-1 and S-2 of the last group of frequency changers are connected with the antenna and also with the loading circuit

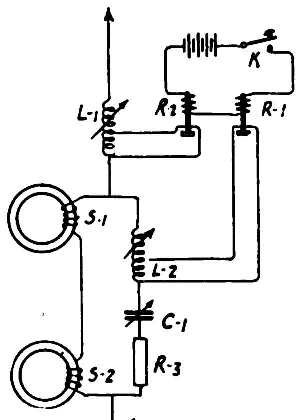


Figure 10—Signaling circuits for maintaining a constant load on the radio frequency alternator

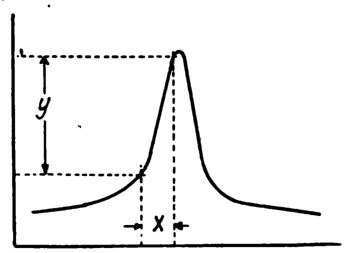


Figure 11—Curve showing antenna current for various values of impedance of the control system

containing the ballast resistance R-3, the condenser C-1 and the inductance L-2. It is readily seen that the connections with the relay R-1 can be so arranged that when the antenna circuit is tuned to resonance with the frequency changers, the relay R-2 detunes the load circuit and when the antenna circuit is de-

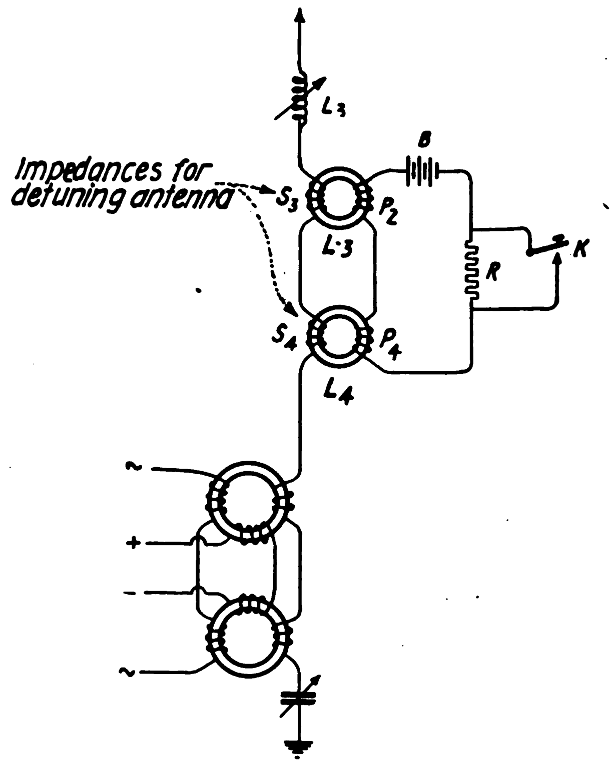


Figure 12—Diagram of a simple system for varying the antenna current

tuned, the load circuit is tuned to frequency of the alternator.

While this method of control possesses operative features, it still carries the disadvantage that circuits carrying high frequency currents of considerable power are actually interrupted. However, by providing mono-inductive impedances for the purpose of detuning, it is possible to adjust the auxiliary magnetising current so that no actual interruptions of the high frequency circuit are required to shift the load from the antenna to the auxiliary loading circuit. Such a system is shown in the diagram of connections in figure 13, but before entering into a description of this system we shall disclose another method of connection whereby the antenna current can be varied in a simple manner. The diagram therefor is shown in figure 12, where two one-way impedance coils L-3 and L-4 have their secondaries S-3 and S-4 respectively, connected in series with the antenna circuit. Their primaries P-2 and P-4 are fed by the direct current source B, the circuit including the key K and the shunt resistance R. Just how this circuit functions will be clear from consideration of the resonance curve shown in figure 11 where the current through the windings S-3 and S-4 is plotted against their self-induction, variation of which is obtained by change in the value of the direct current through P-2 and P-4.

If the impedances S-3 and S-4 are properly designed, it is clear from the curve that a very small variation of the magnetising current will cause a large change in their self-induction. The change of inductance may then be selected so as to completely detune the antenna circuit. The resistance R is of such dimensions that when it is not short-circuited, the direct current is decreased to a value so that the antenna is detuned by change of impedance and accordingly very little energy is withdrawn from the radio frequency changers. When the key is pressed the self-induction of S-3 and S-4 is reduced so as to tune the circuit, the antenna radiating at the frequency of the frequency transformers. It is obvious that a microphone could be inserted in the circuit instead of the key K and speech signals transmitted as in ordinary wireless telephony.

The windings S-3 and S-4 are so disposed on their cores that one-half cycle of the generator output is impeded by one impedance and the other half-cycle by the other impedance. Sufficient modulation could be obtained by the use of one coil, but for wireless telephony it is desirable that both halves of the complete cycle be prevented from flowing in the antenna circuit.

In case an auxiliary loading circuit such as previously shown in figure 9 is connected with the radio frequency changers, the two one-way impedances may be used for alternately tuning and detuning the antennna and the loading circuit, that is, the load is alternately shifted from one to the other. The diagram of connections is shown in figure 13 where the one-way impedances have their secondary windings S-3 and S-4 in series with the antenna and with the secondary windings S-5 and S-6 of the radio frequency changers. The complete antenna circuit is shunted by

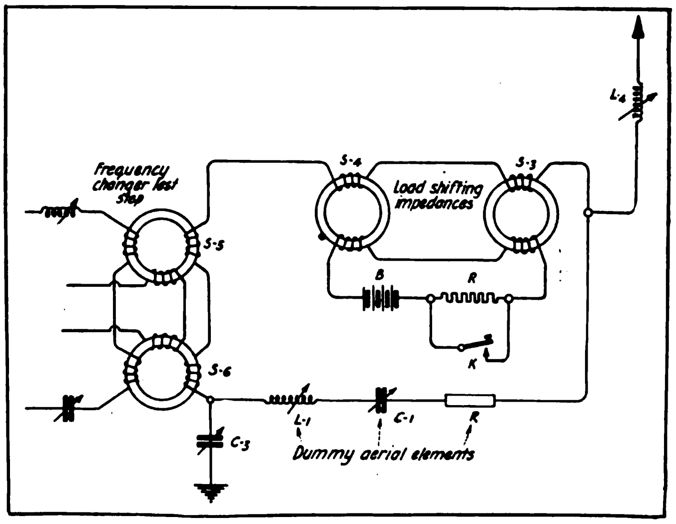


Figure 13—Mono-inductive impedances for detuning the antenna circuit and transferring the load to a dummy aerial

the load circuit, including the ballast resistance R, the variable capacity C-1 and variable inductance L-1 which constitute an auxiliary loading circuit. As usual the primaries of S-4 and S-3 are energized by the source B in series with key K shunted by the resistance R. The antenna inductance is indicated at L-4 and the series variable condenser at C-3.

It is clear that by proper design of the auxiliary loading circuit, and careful adjustment of the D.C. magnetization of the cores of S-4 and S-3, a combination can be effected whereby when the key is closed the change in the self-induction of S-3 and S-4 will tune the antenna circuit to resonance with the alternator and at the same time will place the circuit S-3, S-4, S-5, S-6, L-1, C-1, R out of resonance with the alternator. On the other hand, when the key is raised the self-induction of S-4 and S-3 will be varied by such an amount as to place the auxiliary circuit in resonance with the generator simultaneously detuning the antenna circuit thereby maintaining a constant load on the generator.

A particularly effective arrangement for tuning and detuning the antenna and the loading circuit is to

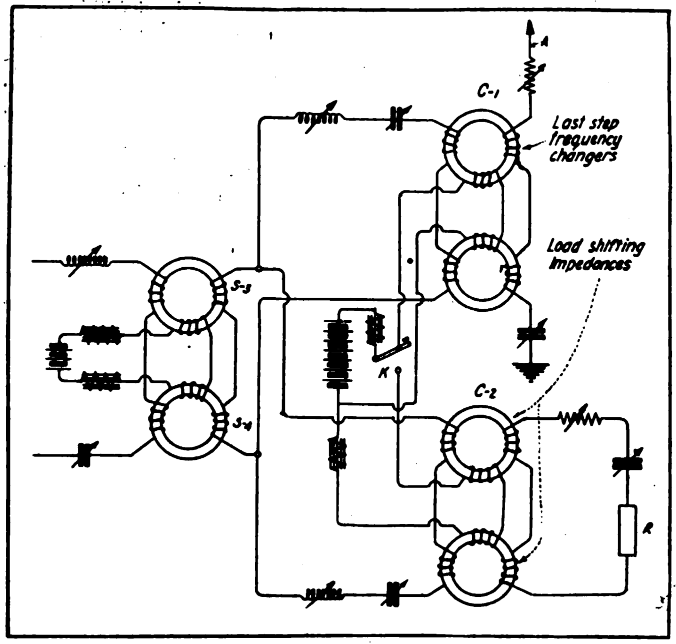


Figure 14—Special load shifting circuit

employ the auxiliary magnetising circuit of the frequency changer as shown in figure 9. The yokes Y-1 and Y-2 of the group of radio frequency changers, in addition to the secondary windings S-3 and S-4, carry the windings S-5 and S-6 which are part of the auxiliary loading circuit comprising the inductance L-1, the variable condenser C-1 and the ballast R. This circuit also includes key K-2. If the current intensity of the magnetising circuit is varied by operating the key K-4 (shunting the resistance R-3) the antenna may be automatically tuned when the key is closed and the auxiliary loading circuit may be tuned and the antenna detuned when the key is open. This circuit, however, operates with the disadvantage that through variation in the direct current intensity, the energy output of the frequency changer is varied so that it is difficult to maintain the output constant for necessary resonance.

This fault may be corrected by employing the connections shown in figure 14, where the second last frequency changer group is connected at its secondary windings S-3 and S-4 with two frequency changers, both being connected in parallel to the last group. The group C-1 discharges its current into the antenna A and the group C-2 is connected with a non-radiating circuit including the load R.

If the group C-1 and C-2 are of uniform dimensions, the load of the generator and that of the changer groups C-1 and C-2 remain constant if one or the other of the two parallel sets is thrown into operation. These sets are alternately operated by changing the auxiliary magnetising current from one set to the other by means of a key K fitted with double contacts.

In place of this key a relay such as shown in figure 10 operated by an auxiliary circuit and an ordinary key may be employed. In this case, satisfactory operation

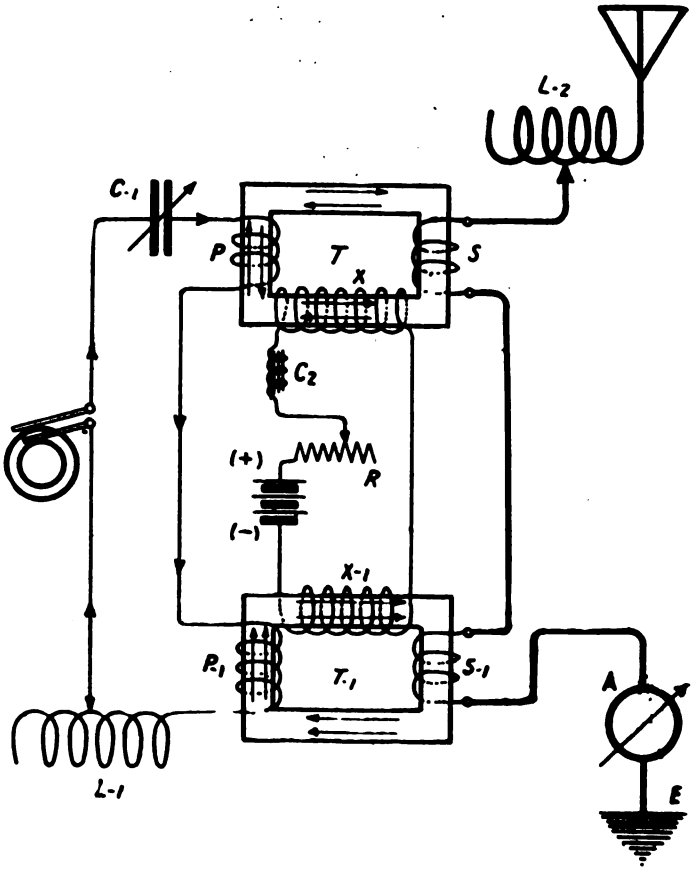


Figure 16—Fundamental wiring diagram of a single step radio frequency changer. The primaries of the transformers T and T-1 are mono-inductive, their cores being saturated by excitation windings X and X-1. When in either transformer the flux generated by the current from the alternator opposes the flux of the excitation winding, a complete cycle of current is induced in the secondary winding. In the diagram, transformer T is active, transformer T-1 inducing no current in the secondary winding S-1 because the fluxes are in the same direction and the core is saturated by the D.C. source

is secured by weakening the direct current as has already been shown in figure 13, but this must take place alternately in sets C-1 and C-2.

The only objection to the parallel arrangement of these two sets is that when the circuits in which they discharge their energy are detuned, the primary current rises to an excessive value which in some cases may completely upset the working of the apparatus. This may be overcome by arranging groups C-1 and C-2 in a series connection with the preceding group as shown in figure 15. In this case the tuning and detuning of two circuits is obtained by means of magnetically operated relays R-1 and R-2 as shown in connection with a previous diagram.

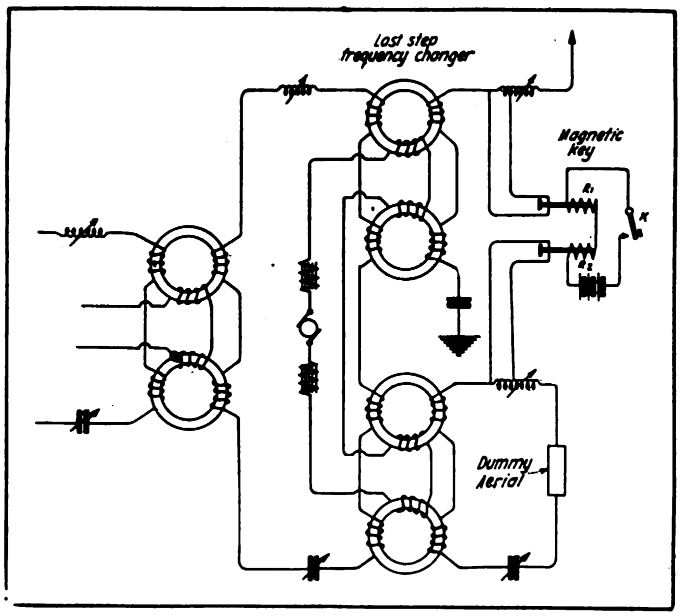
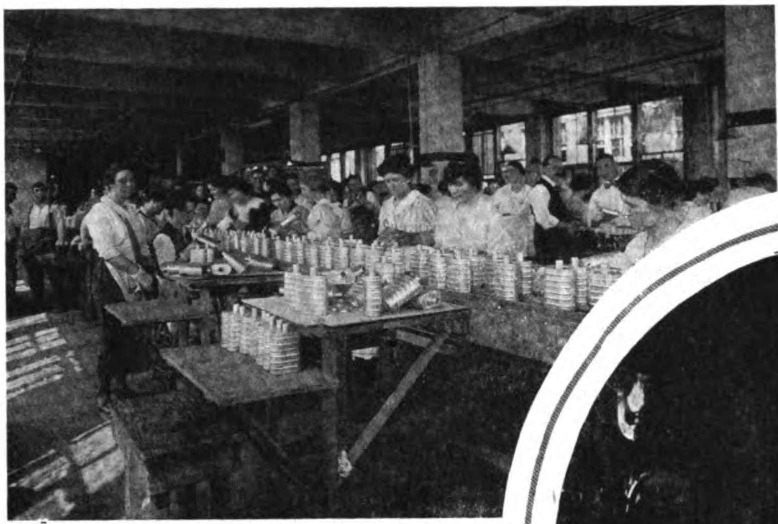


Figure 15—Diagram for tuning and detuning the antenna load circuits alternately by means of magnetically operated relays

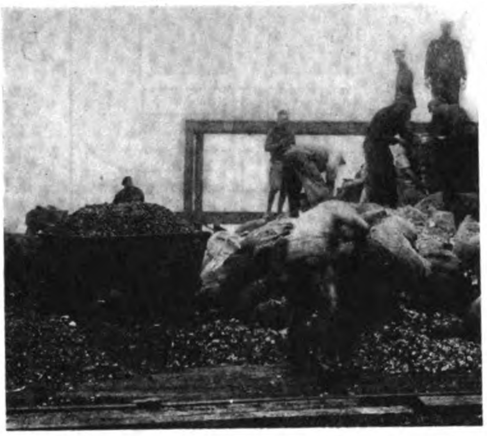
(To be continued)

Gas Masks

A Triumph of Science



Factory inspection of the carbon and chemicals which are contained in the respirator canister



Photos: Press Ill. Svce.

Above, in circle, the great retorts wherein the fruit pits are changed into charcoal

At the left, piles of fruit pits on the docks being loaded for transportation to the furnaces to be turned into charcoal, which, with chemical compounds, has made poison gas harmless

The finished product in use; a drill which requires adjustment of the masks in six seconds

Practical Wireless Instruction

A Practical Course for Radio Operators

By Elmer E. Bucher

Director of Instruction, Marconi Institute

PART II—ARTICLE II, OF WARTIME WIRELESS INSTRUCTION

EDITOR'S NOTE—Part 1 of this series of lessons began in the May, 1917, issue of THE WIRELESS AGE. Successive installments were devoted to the fundamental actions of radio transmitting and receiving apparatus for the production and reception of damped oscillations.

Part 2, the present series, will deal with undamped wave generators, including bulb transmitters and receivers for the reception of undamped oscillations. The direction finder and other special appliances employed in radio telegraph work will be treated fundamentally. A discussion of the basic principles of wireless telephony will terminate the series.

The outstanding feature of the lessons has been the absence of cumbersome detail. The course will contain only the essentials required to obtain a government *first grade commercial license certificate* and to supply the knowledge necessary to become a first rate *radio mechanic*.

RADIO FREQUENCY ALTERNATORS

(1) The direct generation of radio frequency currents in dynamos has been accomplished. Such dynamos are generally termed **radio frequency alternators.**

Radio frequency alternators may be classified as follows:

(a) **The type in which radio frequency currents up to 100,000 cycles per second are generated by an armature rotating at very high speed-up to 20,000 R.P.M.**

(b) **The type in which radio frequencies below 50,000 cycles per second are generated by a normally low speed alternator at shaft velocities up to 3,500 R.P.M.**

(c) **The type in which frequencies are multiplied in the same machine—the armature rotating at comparatively low speeds. In this type the frequency is multiplied by the "reflector" principle.**

(d) **The type in which a comparatively low speed armature generates currents from 5,000 to 15,000 cycles per second, the frequency being further multiplied by external mono-inductive radio frequency transformers.**

Examples of (a) and (b) are the **Alexanderson** high speed and low speed **radio frequency alternators.** An example of (c) is the **Goldschmidt reflector alternator.** Examples of (d) are the **Joly-Arco** and the **Arco-Meissner systems.**

COMMERCIAL UTILITY

(2) None of the aforementioned systems have been employed extensively in commercial radio communication, but some promising results have been obtained in experimentation. All four types with the possible exception of the Arco-Meissner system **are not adapted for transmission on the shorter wave lengths below 2,500 meters.** These systems therefore require aerials of rather large dimensions, the use of which is not possible on vessels of small tonnage. They have proven feasible, however, for long distance land station transmission at fixed wave lengths.

(3) The design of high speed radio frequency alternators involves advanced mechanical and electrical problems, chief among them being

(a) **The high peripheral velocity of the rotor.**

(b) **The limited space available for the stator windings consistent with a rotor of small diameter.**

(c) **The expenditure of extraordinary driving power to overcome air friction.**

(d) **Special design of the bearings to withstand high speeds.**

It is essential that the iron and copper losses and magnetic leakage be reduced to a minimum.

To reduce heating losses due to hysteresis, the stator and rotor supports are made of fine iron laminations. Artificial cooling means must be provided. For example, in one system refrigerated air is supplied to the rotating armature and in another system the radio frequency alternator is specially designed for water cooling.

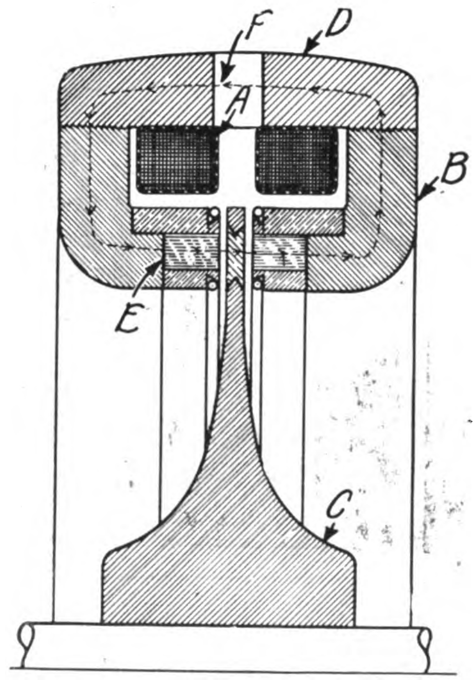


Figure 187

OBJECT OF THE DIAGRAM

To show the fundamental construction of one type of Alexanderson's radio frequency alternator.

DESCRIPTION OF THE DRAWING

The diagram is a cross-section of the machine. The **armature windings** are stationary and are supported by the **laminations** E. The **field magnets** are indicated at A which send a flux through the cast iron frame D, the armature winding supports B and E, and the disc C. The air gap between the armatures and the disc C can be carefully regulated for maximum efficiency.

The circumference of the disc C is provided with **slots** which are milled through the rim. The remaining spokes of steel are filled between with **phosphor bronze lugs** which are riveted in place to withstand the high armature velocity and are trimmed down to provide a smooth surface to reduce air friction.

The standard 100,000 cycle rotor is made of **chrome-nickel** steel with 300 slots.

The shaft of the alternator is long and flexible permitting the rotor to find its center and thereby avoiding extensive shaft strains.

The armature coils consist of **U shaped windings.** Two consecutive U formed wires may be considered as a pair of coils of one turn each joined in series.

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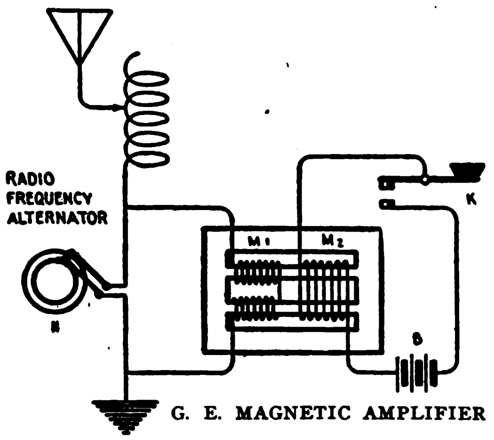


Figure 188

OBJECT OF THE DIAGRAM

To show the fundamental circuits of the Alexanderson magnetic amplifier for controlling the output of a radio frequency alternator and therefore the magnitude of the antenna current.

DESCRIPTION OF THE DRAWING

A specially constructed iron core transformer has the parallel windings M-1 wound oppositely on the two legs of the core as shown. The terminals of M-1 are connected to the radio frequency alternator N. The control winding M-2 includes both legs of the core of M-1, DC current being supplied by the battery B.

OPERATION

If the key K is closed, DC current from the generator or battery B saturates the core magnetically and the inductance of the windings of M-1 will be that secured without an iron core. On the other hand, if the key K is open, the iron core is saturated by the winding M-1 and its self-induction is then maximum. It is thus seen by closing the key K that the current generated by the alternator is withdrawn from and fed to the antenna circuit to form the dots and dashes of the telegraph code.

SPECIAL REMARKS

(1) If a **microphone transmitter** is connected in the control circuit of M-2 the reluctance of the magnetic circuit of M-1 is varied at speech frequency and the magnitude of the antenna current varied accordingly.

(2) Inasmuch as the two branches of winding M-1 are wound relatively opposite to M-2, one branch will oppose the ampere-turns of M-2 on one-half cycle of the radio frequency current, and the other branch during the next half cycle.

(Continued from page 24)

OPERATION

The magnetic flux set up by the field poles A has the direction indicated by the arrows. When a tooth on the rotor comes opposite the armature B, flux passes through the coils B, and as the rotor revolves the non-magnetic material between spokes occupies the same position, whereupon the path of the flux is broken. Currents of radio frequency are thus induced in the windings B, the terminals of which may be connected directly to the aerial and earth wires of a complete transmitting system.

SPECIAL REMARKS

(1) The terminals of the radio frequency alternator may be connected to the earth and aerial directly. It is preferable, however, to place a **step-up** or **step-down transformer** between the aerial and generator.

(2) When the terminals of a radio frequency alternator are connected to the aerial and earth directly, a rise in voltage takes place so that the E.M.F. in the alternator may approximate from 2,000 to 3,000 volts.

(3) Alexanderson has eliminated this phenomenon by providing an **air-core radio frequency transformer between the alternator terminals and the antenna.** For example, in one design the primary winding had 32 distinct coils connected in parallel to 32 different circuits leading from the stator windings of the alternator. A variable connection from the secondary is attached to the antenna to provide voltages suitable to aerials of different characteristics.

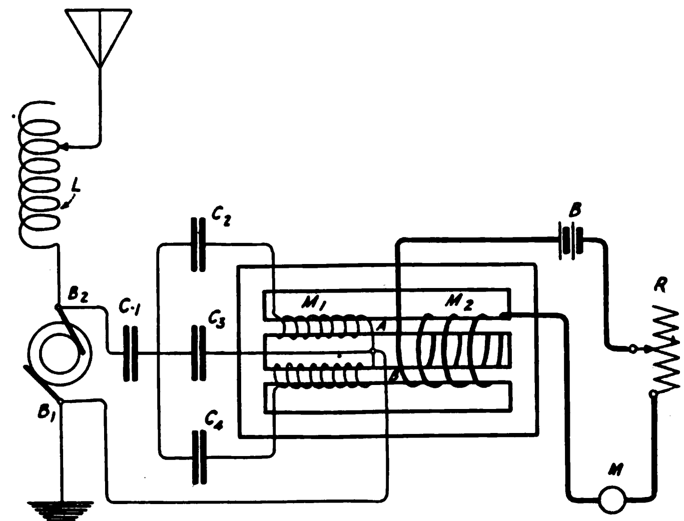


Figure 189

OBJECT OF THE DIAGRAM

To show the complete circuits of Alexanderson's magnetic amplifier for obtaining large modulations of antenna current at audio frequencies with a minimum of control current.

DESCRIPTION OF THE DRAWING

The brushes B-1 and B-2 of the radio frequency alternator are shunted by the AC windings M-1 of the magnetic amplifier.

Coils A and B of M-1 **are connected in parallel** and in magnetic opposition.

Condensers C-2 and **C-4** are in series with branches A and B respectively, and **condenser C-1** is in series with impedance M-1 to minimize its reactance and to permit a linear control of the current diverted from the antenna system through M-1. M-2, the DC control winding includes the legs of both branches of M-1. **DC excitation current** is supplied by battery B in series with which is the regulating resistance R. M may represent a **microphone transmitter** or a **telegraph key,** or the current in M-2 may be controlled by a **vacuum tube relay.**

OPERATION

It must be remembered that the object of the magnetic amplifier is to modulate the antenna circuit at **audio frequencies** either for **wireless telephony** or **telegraphy.** This modulation is effected by diverting the current from the antenna circuit through the turns of M-1 by variation of its impedance. For the best operation it is essential that the ampere turns of M-2 approximate those of M-1. Variation of the DC excitation current causes a marked variation in the self-induction of M-1 and accordingly the voltage drop across the alternator. By the addition of the several condensers in the circuit shown, a very sensitive control of the impedance of winding M-1 is obtained with a minimum of excitation current in the control winding M-2. As a general explanation of the phenomenon of the amplifier it may be said that if the core is saturated by M-2 the **self-inductance of M-1** is that of a **simple winding without an iron core,** and, therefore, the current through M-1 or in other words, the voltage drop across the alternator is relatively great; but with zero DC current in the coil M-2, the **self-induction of M-1 is maximum** and the flow of current from the alternator through M-1, relatively small. Some of the relations between excitation-current, alternator E.M.F., and corresponding current flow through M-1 will be shown in the curve to follow.

With the connections of figure 189 applied to a particular set of his design, it was shown by Alexanderson that a current of **0.2 ampere turned on and off in the coil M-2 caused the output of a 50 kw. radio frequency alternator to vary between 5.8 kw. and 42.7 kw.**—a variation of 37 kw.

Special Remarks

(1) The branches of M-1 in figure 189 are in parallel instead of in series as in figure 188.

(2) This connection gives a lower impedance, which, with a certain control current in M-2 gives greater sensitiveness and permits the handling of large currents without arriving at an undesirable condition of instability of operation.

(3) The effect of the condensers C-2 and C-4 is as follows: If the branches A and B were in parallel without condenser C-2 and C-4 in series as shown in this diagram, and the control current in M-2, for example, was varied at an audio frequency, there would be produced a short circuit current between the branches A and B. without producing any flux variation for the radio frequency current; but since the branches A and B

need carry only radio frequency current, condensers C-2 and C-4 are chosen of suitable value to act as a short circuit for the radio frequency current and an open circuit for the audio frequency current generated by the control winding M-2.

(4) The condenser C-1 increases the sensitiveness of the entire system so that a very much smaller DC control voltage is required to vary the output of the alternator. This condenser also permits a linear control of the antenna current; that is, a control whereby the antenna current varies directly with the amplitude variation of the current in the control circuit M-2. Such control is necessary for perfect speech reproduction in radio telephony.

If the capacity of C-1 is selected to neutralize the inductance of M-1 for some definite value of control current in M-2, the impedance of the alternator shunt circuit becomes a minimum. For any lower value of control current, the impedance is determined by the difference between the inductive reactance of coil M-1 and the capacity reactance of C-1. The smaller the difference between these two values of reactance the lower will be the control current required to reduce the alternator voltage to a minimum. In other words, a very slight variation in the DC control current will cause a very great drop of E.M.F. across the alternator and therefore will vary the antenna current in accordance.

(5) Still better control of the alternator output is obtained by providing a shunt condenser C-3. Its value is so chosen that the current through the amplifier at low excitation will be a leading current instead of a lagging current. The condenser, therefore, permits the alternator to assume its full maximum voltage.

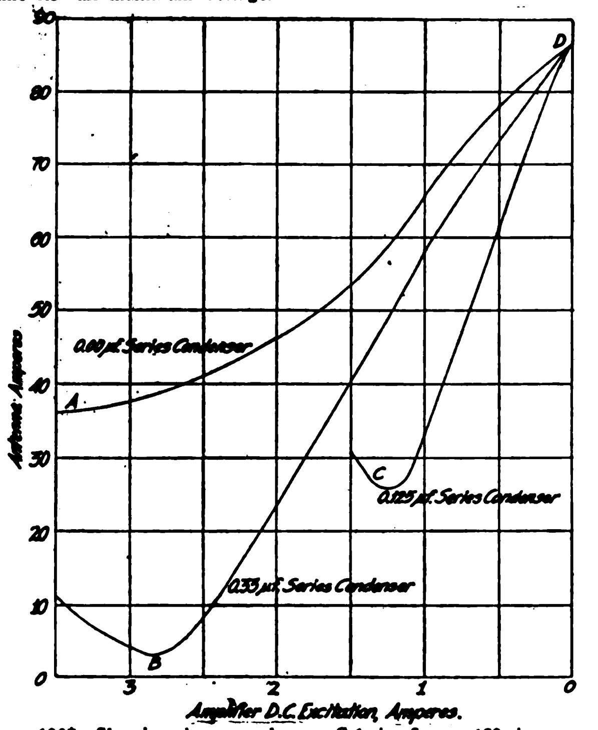


Figure 190*—Showing how condenser C-1 in figure 189 increases the sensitiveness of the magnetic amplifier. The horizontal axis shows the DC excitation current and the vertical axis the actual antenna current. It is clear that with the condenser of .33 microfarads and with DC excitation current less than 2.8 amperes, the change in antenna current is very much greater than with the other two values of capacity shown. Besides a linear control of the antenna current is secured

*Taken from "Radio Telephony" by Dr. Alfred N. Goldsmith.

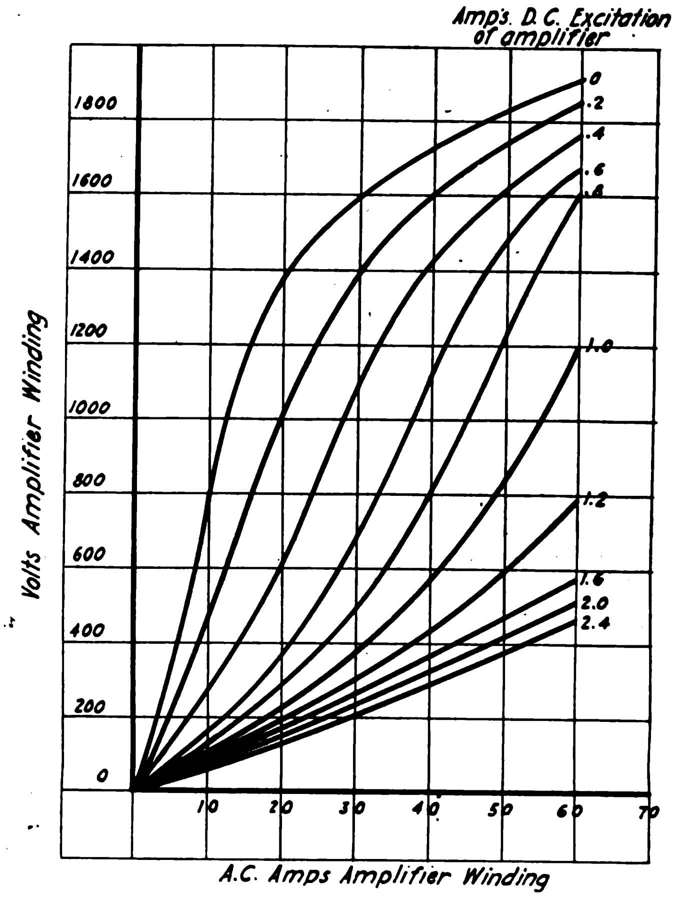


Figure 191*—Showing how the impedance of the magnetic amplifier varies with different alternator voltages and different values of DC excitation current in the control winding of M-2, figure 189

For example, at 800 volts the current through the amplifier varies from 10 amperes for zero current in the DC control circuit to 60 amperes for 1.2 amperes in the DC control circuit. In other words, if a telegraph key be inserted in the DC control circuit of figure 189 and the magnetizing current in M-2 be varied from zero to 1.2 amperes the alternator output would change between 60 and 10 amperes and there will be a corresponding change of current in the antenna circuit

Again at 1200 volts, the current through the amplifier varies from 15 amperes for zero DC control current to 60 amperes for 1 ampere DC control current; and at 800 volts the current from the amplifier varies to 10 amperes for zero DC control current to 33 amperes for .6 amperes DC current. It is clear that with a given alternator and amplifier, some combination of DC current and alternator voltage can be selected whereby a ridiculous small value of DC excitation current can cause an extremely large variation in the output of the alternator. Particularly so, if the capacities of the condensers shown in figure 189 are properly chosen

*Shown by Alexanderson in volume 4 No. 2, Proceedings I.R.E., April, 1916.

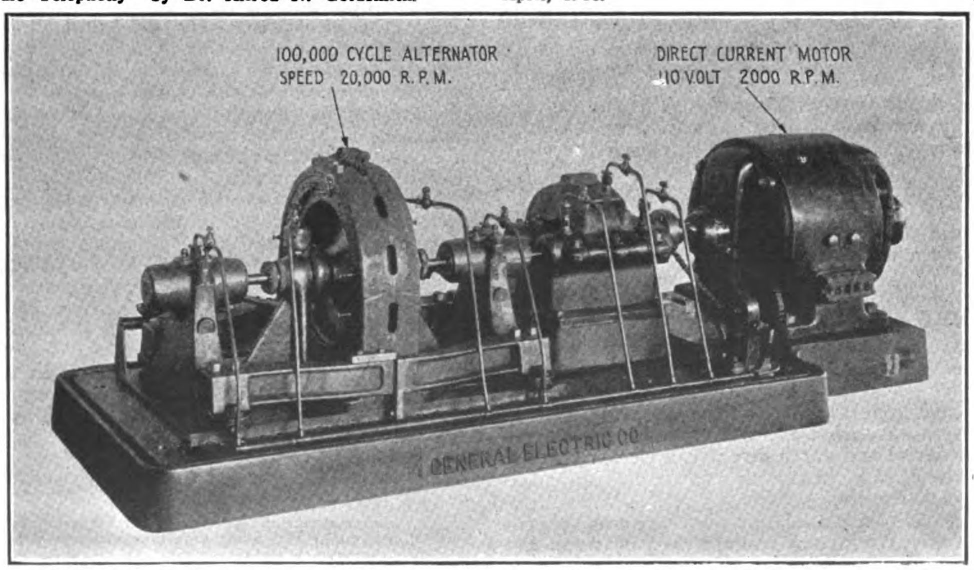
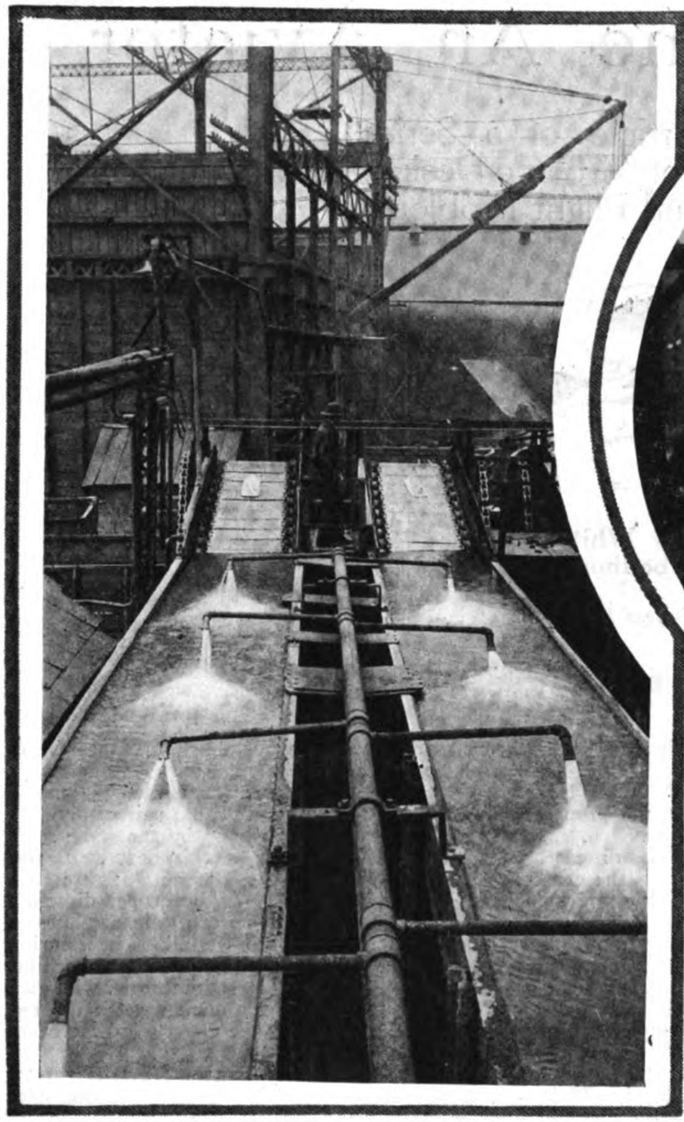
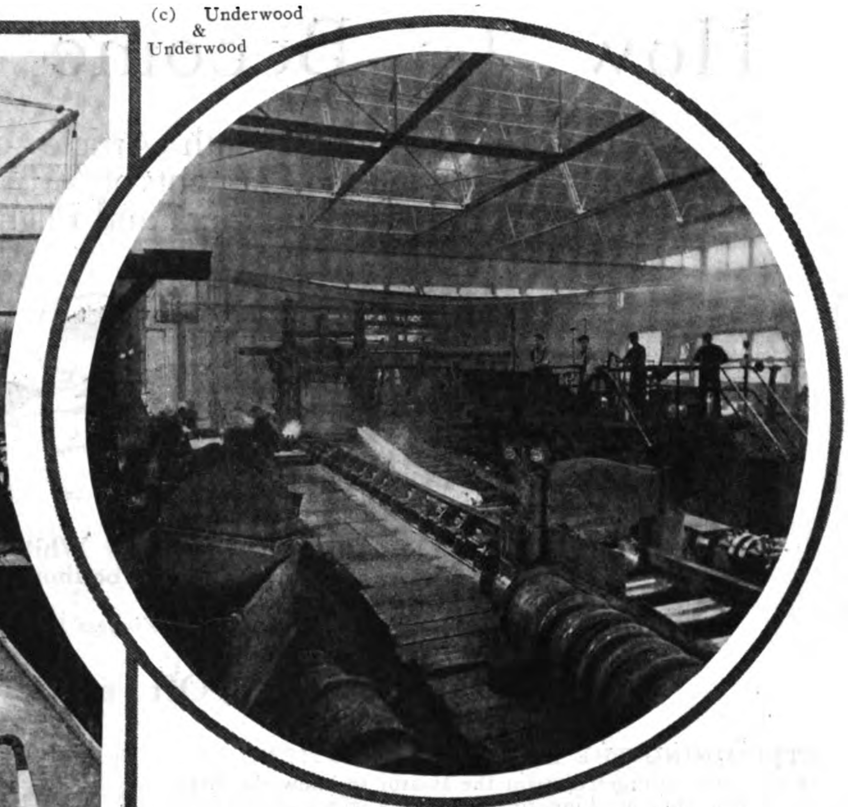


Figure 192—The 2kw. 100,000-cycle Alexanderson radio frequency alternator. The normal speed of the alternator is 20,000 revolutions per minute. It is driven through a turbine 10 to 1 gear by a 110-volt DC motor rotating at 2,000 revolutions per minute. Oil is supplied to the bearings under pressure and a special cutout valve is attached to the oil pipes, which if the oil stops flowing, trip the circuit breaker in the DC line thereby protecting the generator bearings. To prevent binding of the thrust bearings, the generator is provided with a system of equalizing levers which compensate for shaft heating

The output of these alternators is approximately 10 amperes at 200 volts or 20 amperes at 100 volts, depending upon the load and the mode of connection between the armature and the output circuit. The inductance of the armature is .08 microhenries, the armature resistance 1.2 ohms at the frequency of 100,000 cycles



(c) Underwood & Underwood



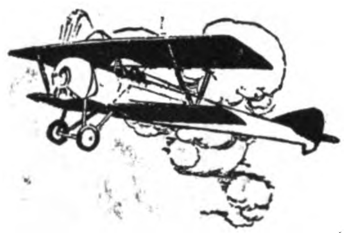
Steel for France

How the United States has turned its commercial genius from making war to preparing for rebuilding devastated countries overseas, is illustrated in these three views of one industry's activities. Above, in circle, is seen a rolling mill interior with a rail emerging for eventual use in transporting material and supplies through Flanders and Lorraine. At the left, pig iron on belt conveyors passing through the cooling troughs

Speed, and yet more speed, is the eternal cry of those who make the steel for the victorious nations. Here is shown the start of the operation revealed above; the giant ladles pouring molten metal into the moulds which the belt conveyors carry directly to the cooling troughs

How To Become An Aviator

The Seventeenth Article of a Series Giving the Elements of Airplane Design, Power, Equipment and Flight Problems



By J. Andrew White and Henry Woodhouse

Laying Off a Course

DETERMINING THE STEERING DIRECTION

It is obviously important for the aviator to know the direction to head his machine to arrive at a given destination. When flying above clouds, over water, or at night, when landmarks are not discernible, he has no means of determining how far the wind may be blowing him off his course. Calculations are therefore made in advance by the following method:

DATA REQUIRED:

Flying speed of his airplane.
Compass bearing of his course from point of departure to destination.
Direction and speed of the wind.

The map of the country over which he is to fly will give him the compass bearings; the points joined by a line (see Figure 106) determine the direction and its angle to the north of the compass bearing.

Direction and speed of the wind can be found from the weather vane and anemometer of the airdrome. The anemometer is a device with four arms carrying cups on the end of each, turning about on a vertical axis at a speed varying with the wind velocity. When the wind velocity at the ground has been determined, the aviator must decide upon the height at which the flight is to be made; for as height increases the velocity and direction of the wind changes. The table below will be found useful in estimating the proper allowance:

WIND VELOCITY AND DIRECTION CHANGES WITH ALTITUDE
(*Based on Wind Velocity of 25 miles per hour*)

Height in feet	At the earth's surface	500′	1000′	2000′	3000′	4000′	5000′
Velocity change in per cent.	100%	135%	172%	188%	196%	200%	200%
Clockwise deviation in degrees	0	5°	10°	16°	19°	20°	21°

Example: Assume that the anemometer shows a wind velocity of 25 miles per hour at the ground, and the weather vane indicates the direction of the wind 89° west of north. The aviator plans to fly his course at a height of 3,000 feet. From the table he learns that the wind velocity at this altitude is 196% greater than at the ground; then, $25 \times 1.96 = 48$ miles per hour. Likewise, from the table, it is seen that the wind direction at this altitude shows a clockwise deviation of 19°, so at 3,000 feet the direction of the wind will be 89° — 19° = 70° west of north.

A DIAGRAM TO DETERMINE THE WIND FACTOR

With the data in hand the aviator can lay out a simple diagram for his course. Assume that his orders call for a flight from Fort de Villeneuve to Bougy (see *A-B*, figure 106). The route, according to the map, is 30° east of north. The speed of the aviator's airplane is 80 miles per hour. The wind, as already determined, has a velocity of 48 m.p.h. in a direction of 70° west of north at 3,000 feet, at which height the flight is to be made.

Either on the map or on a separate sheet of paper, the starting point is designated *A* (see figure 107). A line is then drawn with the proper compass bearing to the destination *B*. From point *A* a line is drawn parallel to the direction of the wind, blowing 70 degrees west of north. On this line the velocity of the wind is measured off, the aviator establishing a scale, say 1 inch = 10 miles, *or any other convenient scale.* Assume that the scale 1 inch = 10 miles is the one selected; then 48 m.p.h. would be measured, 4.8 inches to point *C*. With a pair of dividers opened to represent the speed of the airplane by the same scale (in this case, 80 m.p.h. = 8.0 inches) an arc is described with *C* as the center. Where it cuts the line *A-B* (see *D*, figure 107) a line is drawn from *D* to *C*; this line gives the proper direction to steer the airplane to neutralize the drift of the airplane in one hour's flight from *A* to *B* in the cross wind. The steering is by compass bearing to the fore and aft axis of the machine.

Measurement of the line *A-D*, applied to the scale will give the actual velocity in miles per hour of the flight. In the example it is seen to be 85 m.p.h., that is, the cross wind increases the airplane's speed 5 miles per hour.

The student should reconstruct the diagram for the return flight. That it will not do to steer in exactly the opposite direction will then be made clear. In all cross-country flights a separate diagram for the return is required, unless, of course, the wind happens to be exactly parallel to the course.

RADIUS OF ACTION

To determine the distance outward the airplane can go and have sufficient gasoline to return, requires a simple calculation.

The aviator knows his gasoline capacity; i.e., how many hours of flight can be obtained before the tank is empty. With this and the other data he can figure his radius of action in miles.

Example: Assume that the flight is to be made straight into a head wind of 30 miles per hour, the speed of his airplane is 80 m.p.h., and its gasoline capacity $4\frac{1}{2}$ flight hours. (For climbing and as a general margin $\frac{1}{2}$ hour gasoline consumption is deducted, leaving 4 flight hours.)

On the outward trip his speed is $80 - 30 = 50$ m.p.h.
On the return trip his speed is $80 + 30 = 110$ m.p.h.

The ratio for both trips is, then, as 50 is to 110, or 5 is to 11. The time required for the outward trip is thus 11/16 of 4 hours, and the return trip the remaining 5/16 of 4 hours; or, outward = $2\frac{3}{4}$ hrs.; return = $1\frac{1}{4}$ hrs. Since his outward bound speed is 50 m.p.h., then $50 \times 2\frac{3}{4} = 137\frac{1}{2}$ miles radius. Return speed being 110 m.p.h., then $110 \times 1\frac{1}{4} = 137\frac{1}{2}$ miles. This, then, is the radius of action.

A wind blowing directly along the course is a rare occurrence, however. A diagram similar to figure 107 must therefore usually be made, both for the outward and return trips. The calculation for radius of action is then carried on as above, or by the simple formula:

$$\text{Radius of Action} = a \times \frac{b \times c}{b + c}$$

Where
a = gasoline hours.
b = outward speed.
c = return speed.

Figure 106—How an airplane must be steered off the direct course to allow for side wind drift

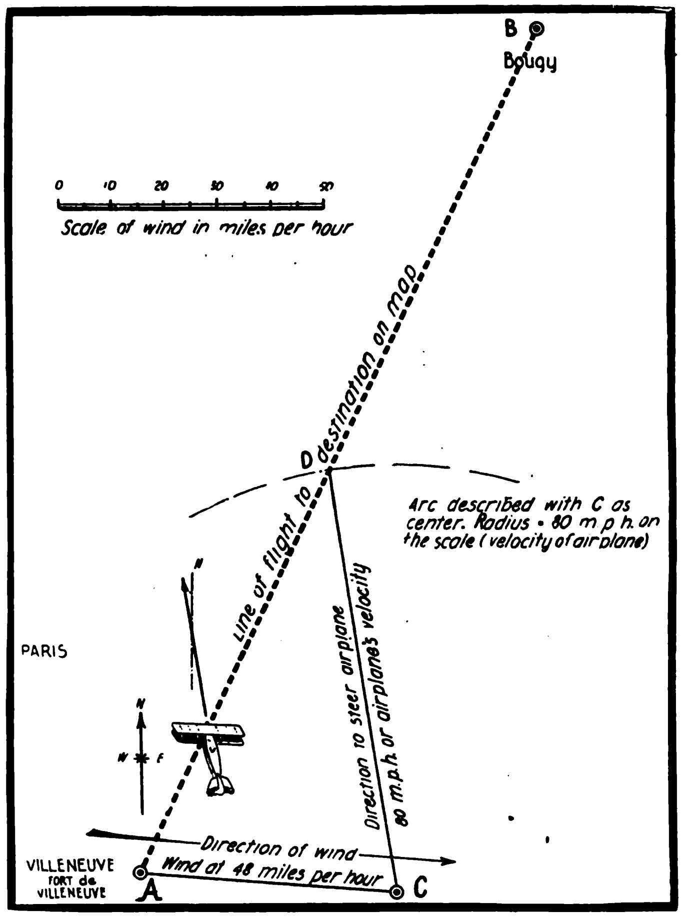


Figure 107—Diagram solution of the flight from A to B shown in figure 106

SOME FLIGHT CONSIDERATIONS

PROPER PREPARATION

Care must be observed by the aviator that his preliminary preparations are properly made. This refers particularly to a study of the course from the map.

Ordinarily the country over which he is to make the flight will be on one sheet with features and landmarks clearly indicated. Should the use of two sheets be necessary these should be pasted together before starting and cut to fit the map roll. In war flights foreign maps with the scale in fractions are often the only ones available; the aviator should immediately construct the corresponding scale at so many miles to the inch, which will facilitate rapid calculation. Distances from the starting point should also be marked at ten mile intervals or by distinctive objects to be passed. High hills should be marked as bad for landing.

HEIGHT

Where there are no high hills or mountains in friendly territory the flight is best made at heights from 1,500 to 3,000 feet. An altitude of 1,500 feet should be attained by an initial circling climb before the aviator sets off on his course. Speed and steadiness of wind increases with height, and landing or righting in case of mishap is better accomplished with a good margin; but above 2,000 feet contour of the country is not readily distinguished, so if the flight is to be at a higher altitude the poor landing places should be clearly marked on the map. It is well for beginners to keep the ground in view throughout the flight, flying under or around any clouds.

CLOUDS, FOG AND STORMS

Pupils are cautioned to avoid heavy cloud banks and not to rise above clouds when near the seacoast for a wind off shore may carry the airplane out to sea without the pilot's knowledge. When navigation above a cloud bank is necessary, the cloud formations may be used as a basis for keeping the airplane horizontally level, for cloud formations are ordinarily sufficiently level for this purpose. Fog should be avoided; in fact, when a heavy mist is encountered a landing should be made as soon as possible. River valleys should be avoided, for they very often hold a ground fog up to a height of 700 feet. At times when the flight must be continued through clouds or fog, the instruments should be carefully watched and the stick control and rudder kept in central position as much as possible. Heavy rain, sleet and hail chip the propeller slightly and when encountered a landing should be made at the earliest favorable opportunity. A whistling sound indicates that the propeller has been chipped.

AIR DISTURBANCES

Initial cross-country flights by the student are usually made under favorable weather conditions, ordinarily in the early morning or late evening, when the atmosphere is calmest. Bumps caused by heat, as explained in a later chapter on meteorology, manifest themselves early in the day as close to the ground as 100 feet; their influence is gradually extended upward as the morning progresses until they are perceptible at noon at altitudes up to 3,000 feet. Clouds and inland waters generally predict bumps, while over the sea the air is ordinarily smooth, although of high velocity. Landings in strong, bumpy winds are best made with additional speed, caution being exercised when nearing the ground in sheltered spots as wind eddies may cause a sudden roll or a drop of 10 feet or so.

LOST BEARINGS

Should something happen to the compass and the aviator be unable to get his bearings, his wrist watch will be of assistance in locating the points of the compass. With the hour hand pointed to the sun, the point midway between the angle it makes with the numeral 12, points to the south. Thus, at 8 o'clock in the morning, with the hour hand pointed at the sun, the point midway in the angle formed by 8 and 12, i.e. 10 on the watch dial, will point to the south.

LANDMARKS

The principal landmarks of a map should be firmly fixed in the aviator's mind prior to the flight, memorized if possible. Experience has shown that the following features are the most useful:

Towns—These are the best guides and should be marked with a circle or underlined on the map. A village is sometimes difficult of identification; location of its church and its reference to the roads will aid in placing it. If flying below 2,000 feet altitude the aviator should not pass directly over

the town as the heat from factory chimneys causes marked air disturbances.

Railways—Railroad tracks are of great assistance. Tunnels, bridges and cuts are marked on the map and aid in locating the line to be followed should the aviator mistake a branch line or siding for the main route. It should be remembered that the track disappears when it passes through a tunnel.

Water—Water courses and lakes are usually clearly defined and may be seen at some distance. Allowances should be made, however, for possible flooding of streams after heavy rains which may change their appearance as recorded on the map. The bearing of a river with reference to the course should be noted; following its windings may involve loss of time.

Roads—From a height all roads look very much alike and are therefore not very good guides. Main roads can occasionally be identified by the paving and the amount of traffic, and are useful because they lead into towns. Telegraph lines may be expected along them, which makes landing nearby dangerous.

Woods—Small forests serve as excellent guides.

Hills—From altitudes of 2,000 feet and over, hills are flattened out in appearance and valleys are not clearly discernible.

General Characteristics—The physical features of the country are very helpful to the aviator if his preliminary study of the map fixes in his mind their relationship to each other. How railways and streams join or intersect, how they enter and leave towns, and their relation to wooded areas, supply useful information. Dividing the course into four progressive parts also aids, if the general nature of each sector is noted for its chief distinguishing characteristics, whether water, woods, farm lands, towns or villages.

FORCED LANDINGS

Engine failure is the main cause of forced landings. As soon as it is known that the failure is complete, the engine should be switched off and the gasoline pipe closed to lessen the danger of fire. The airplane is then turned into the wind and if the ground directly beneath makes landing impossible the descent can be made in a long glide. While selection of landing ground is not practical from a recognition standpoint at altitudes greater than 1,000 feet, entirely unfavorable areas such as water, marshes or forests may be avoided by long glides. The radius of the forced landing is about five times the height at which the airplane is flying. An aviator forced to land from a height of 2,000 feet, therefore has about 10 square miles of land to choose from. At a height of 5,000 feet he has selection in an area of about 70 miles.

When a forced landing has been made the aviator's first thought should be for his machine and the immediate possibility of resuming flight. Examination of the engine is the first step; it should then be determined how much, if any, damage has been done to the airplane structure. A telephone call to his headquarters should then be made and a report given of his location and diagnosis of the trouble. If the damage requires staying where he is for the night, then the airplane should be moved to some spot sheltered from the wind and made secure.

TIME CHECKING

It is difficult to estimate time while flying, yet checking by the watch the time when successive objects are passed is an important detail often overlooked. The tendency invariably is to expect the next landmark long before it is due and confusion will arise in the aviator's mind unless time elapses are carefully checked. Knowledge of elapsed time is also valuable in steering a compass course over the clouds.

SELECTING LANDINGS

Choosing a suitable field to land in is by no means an easy task for the novice. A few primary rules governing selection will be useful.

It is better to pick out a *group of fields* as the glide may take the inexperienced aviator beyond or short of the mark.

Stubble fields, brown in color from a height, are generally smooth and, excepting sandy beaches, make the best landing ground.

Grass fields, green in appearance, often can be identified by cattle grazing. Mounds may be looked for in grass land, so they are therefore second choice.

Cultivated land is ordinarily fairly level, but landings made therein are successful only when pancaked. A ploughed field is black in appearance, vegetable and corn fields have a hue considerably darker than the green of grass lands.

A field *near a town* is the best choice, as its proximity to the source of supplies is a great convenience. The landing field selected, however, is preferably to windward of the town, so it will not be necessary to rise over the buildings when re-starting.

Telegraph wires usually border *main roads and railways;* these wires cannot be seen until the aviator is close upon them, so nearby landing places are undesirable.

When *snow* is on the ground the selection of a good landing place is practically impossible; the frozen ground, however, makes its selection of less importance.

Light variations are important. Flying into the rays of the sun, a slight haze appears which distorts objects. In the late evening, too, the light may be good at the flying altitude, but when descent is made the ground appears much darker. Before landing, therefore, a wide circle should be made until the eyes are accustomed to the relative dulness.

PEGGING DOWN

The airplane should be placed head into the wind and the tail lifted up and supported at a height which will place the airplane's wings edgewise to the wind. The controls should be locked and the wings and fuselage near the tail pegged down, some slack being left in the rope. The propeller, engine and cockpit should then be covered. If a strong wind is blowing, trenches should be dug for the wheels to a depth of about ¼ their diameter.

RE-STARTING

A minor trouble which does not require calling a repair crew may leave the aviator without assistance for starting, although spectators willing to hold back the airplane are generally more numerous than too few. Stones or fence poles will serve as chocks under the wheels if assistance is not at hand. Any mud which may be gathered on the wheels should be cleaned off as it will be drawn to the propeller by centrifugal force and chip or break it. Before starting, the ground over which the machine is to taxi should be walked over carefully and anv serious obstacles removed. The possibilities of dead wind in the lee of buildings should be estimated and allowance made to get clear of these areas as the airplane rises. Small obstacles, such as hedges, may be cleared if good taxying speed is acquired and the control stick pulled back suddenly. Getting rid of extra weight will also aid the machine to take the air quicker, should there be doubt of getting out of the field.

Inventions the Army Needs

J. Andrew White, Editor THE WIRELESS AGE:

The Inventions Section of the General Staff of the United States Army has submitted to the War Committee of Technical Societies the attached problems requiring scientific and inventive talent for solution.

The War Committee, therefore, transmits this request of the General Staff to its membership and requests that the Engineers of America give them serious thought and consideration.

WAR COMMITTEE OF TECHNICAL SOCIETIES,
3549 NEW NAVY BLDG., WASHINGTON, D. C.

Ideas and suggestions should be submitted to

INVENTIONS SECTION, GENERAL STAFF,
ARMY WAR COLLEGE, WASHINGTON, D. C.

PROBLEM NO. I.—LIAISON COMMUNICATION

In operations of our troops fighting in France, all have seen the necessity of perfecting liaison between different elements of the command. This is especially true as regards liaison between elements of the front line troops and between front line troops and elements further to the rear.

Our infantry advances in spite of the most serious resistance offered by the enemy, and the losses suffered are necessarily heavy. These losses can be lessened by increased artillery activity. Liaison between the infantry is now maintained in so far as is practicable, by sending forward with the infantry a large artillery liaison personnel, well equipped with the material of liaison—telephones, wire, flags, projectors, rockets, radio, etc.

This personnel is charged with sending back information whereby fire may be directed on the hostile elements which are causing losses to our troops.

The present system of liaison does not always give

satisfactory results. The enemy's fire frequently cuts off the infantry, and cuts regimental commanders from the units in the front lines. Wire is almost immediately cut by shells; optical signaling becomes impossible on account of smoke and dust, and frequently is interfered with by fog; runners become disabled or killed; pigeons go astray; radio is interfered with by enemy stations, and the antennae are destroyed by enemy fire; ground telegraph is limited in range, and interfered with.

The War Department is desirous of finding new means of communication whereby closer liaison may be maintained by the different elements of a command.

A device for this purpose should be small and compact, without antennae exposed to shell fragments; it should be easily transported by one man, or at the most by three men; it should be capable of being set up quickly, and not present a target to the enemy; it should operate over a distance of at least five miles and be certain of action.

It is believed that the War Department is in possession of the latest developments in so far as radio, telephony, signaling devices and similar apparatus are concerned, but is now seeking for something that is an improvement over all these devices. So far as known, nothing of the kind exists at present, but it is believed, with the inventive genius of the country concentrated along these lines, something desirable may be developed.

PROBLEM NO. II.—AN AVIATION NEED

On night bombing expeditions and even in the daytime, when passing through fog or clouds, an airplane, like a ship, is guided entirely by a compass. Some of the new instruments designed for this work are beautiful examples of the instrument maker's skill, but, unfortunately, when placed where the aviator can see them, they are directly between him and the engine, a position which greatly affects their accuracy.

If a compass should be placed near the outer end of a wing, or at the rear end of the fuselage, it would be practically outside of the magnetic influence of the engine, but at present there is no way to read a compass in either of those positions.

What is needed is some device or arrangement whereby a compass can be mounted far enough away from the engine to be outside of its magnetic influence and still be so arranged that it can be easily read.

PROBLEM NO. III.—A BETTER FIRE CONTROL GEAR FOR FIXED MACHINE GUNS ON AIRPLANES

The forward machine gun on an airplane is fixed and fires between the propeller blades in the direction in which the machine is headed at the time of firing.*

The function of a fire control gear is to control the fire of an aircraft machine gun shooting through the propeller so that no shots will be fired when the blades of the propeller are in a position where they are in danger of being struck. This is done usually by a cam attached to the crank-shaft or geared to the propeller which sends an impulse by mechanical or hydraulic means to the trigger mechanism of the gun only when the propeller is in a safe position for the gun to be fired. This impulse trips the trigger and a shot is fired. As gears are now designed, two impulses are given to the gun every time a blade of the propeller is in a certain position with reference to the bore of the gun.

Fire control gears are of two types: hydraulic and mechanical. The advantages and disadvantages of each type are listed below.

*The considerations governing airplane machine-gun fire and full descriptive test of the armament are contained in the book "Practical Aviation for Military Airmen" by Major J. Andrew White.

HYDRAULIC GEAR. Advantages: Allows gun to be placed in any position with reference to the engine, inasmuch as the hydraulic pipe line can be bent.

Disadvantages: Difficult to fill and take care of. Requires a good deal of special training and experience to get good results. Many small parts to get out of adjustment. Difficulty from leaking.

Lag in impulse due to time taken by hydraulic wave to pass down pipe line. This causes a wide dispersion of shots for changes in the R.P.M. of the propeller. Shots fired at low R.P.M. fall too near one blade of the propeller and shots fired at high R.P.M. too near the other blade; thus the safety margin is cut down and R.P.M. the gun may safely be fired at is limited.

At low R.P.M. the impulse changes from a pressure wave to a simple hydraulic action and the gear cannot then be depended on.

MECHANICAL GEAR. Advantages: Action always positive and certain. No lag of impulse in transmission. Easily taken care of and adjusted.

Disadvantages: Position of gun limited with reference to the engine as it is difficult to send impulses around corner. In case where impulse is transmitted by rods difficulty is encountered from whip. Wear in rods and cams affects timing.

Disadvantages of both types of gears:

In both types of gears the principal drawback is the dispersion of shots between zero speed and maximum speed which limits the type of propeller used and limits the safe firing speeds. This is greatest on hydraulic gears.

Rate of fire of gun dependent on R.P.M. of propeller. For example, if a machine gun is designed to shoot 800 shots per minute and the propeller is turning over at 400 R.P.M., or 800 impulses are given per minute, the gun will fire on every impulse and the rate of the geared gun will be 800 shots per minute. If the propeller is turning at 500 R.P.M., or giving 1,000 impulses per minute, the gun cannot use every impulse, but will use every other impulse, and the rate of fire will only be 500 shots per minute or the efficiency will be decreased. This is an important disadvantage of the present system.

The ideal fire control gear:

(1)—Maximum rate of fire is obtained at all R.P.M. of the propeller. (2)—The time of impulse is advanced as the propeller speed increases so that shots at maximum speed will fall in the same position with reference to the blades of the propeller at the plane of the propeller, as shots at zero speed. (3)—Easily placed at any position with reference to the engine. (4)—Simple to take care of and adjust.

It is obvious that if the first advantage is obtained, the second must be sacrificed, but a better combination of the two is desired than we have at the present.

The problem which presents itself is to devise a fire control gear which incorporates the above advantages. The solution seems to lie in an electrical system.

Calculations must be based on the following data:

Distance from muzzle of gun to plane of propeller varies from 3 to 6 feet. Maximum propeller speed 1,600 R.P.M. Rate of fire of airplane machine gun 1,200 shots per minute.

PROBLEM NO. VII.—IMPROVEMENT IN AIRPLANE CABLE BRACES

The present method of attaching the ends of cables to turnbuckles and anchorages is by bending the end of a cable around a protecting liner and wrapping the overlapping end with brass wire, and then soldered.

This is an unsatisfactory, wasteful and expensive method. If some very simple method of anchoring cable ends could be devised, it will greatly speed up the production of aircraft.

Aviation News

Pershing Honors Gallant Aviators

The Commander in Chief of the American Expeditionary Forces, in the name of the President, has awarded the distinguished service cross to the following officers and soldiers:

First Lieut. Joseph C. Raible, Jr., 147th Aero Squadron. — For extraordinary heroism in action near Château-Thierry, on July 5. He and three other pilots, at an altitude of 4,700 meters, attacked an enemy formation of eight battleplanes flying at an altitude of 5,000 meters. Home address: J. C. Raible, 2,102 Chestnut Street, Hannibal, Mo.

First Lieut. Arthur H. Alexander, 6th Aero Squadron.—For extraordinary heroism in action on September 4. While on a bombing expedition with other planes from his squadron Lieutenant Alexander engaged in a running fight over hostile territory, with a superior number of enemy battleplanes, from Friauville to Lamorville. Home address: Mrs. Stella H. Alexander, Box 105, Wellesley, Mass.

First Lieut. Donald B. Warner, 96th Aero Squadron.—For extraordinary heroism in action on September 4. During the combat he was severely wounded, his right thigh being badly shattered. In spite of his injuries, he continued to operate his machine guns until the hostile formation had been driven off and one plane shot down burning. Home address: Mrs. C. E. Warner, 175 Humphrey Street, Swampscott, Mass.

First Lieut. Alfred A. Grant, 27th Aero Squadron. —For extraordinary heroism in action near Château-Thierry, on July 2. By skilful maneuvering and good marksmanship he destroyed one machine and drove off the other two. Home address: Alfred A. Grant, father, 86 Syracuse Street, Denton, Texas.

First Lieut. Charles W. Drew, 13th Aero Squadron. — For extraordinary heroism in action near Flirey on August 15. He operated one of a patrol of four machines which attacked four enemy battleplanes. In the fight which followed he attacked in succession three of the enemy airships, driving one of them out of the battle. He then engaged another machine at close range and received ten bullets in his own plane, one of which penetrated his radiator, while another pierced his helmet. In spite of this he followed the German plane to a low altitude within the enemy's lines and shot it down in flames. Next of kin: Mrs. S. E. Drew, 246 West Seymour Street, Philadelphia, Penn.

Second Lieut. Arthur H. Jones, 147th Aero Squadron.—For extraordinary heroism in action in the Toul sector on July 16. He and four other pilots were attacked by nine German pursuit planes. Without hesitation, he dived into the leader of the enemy formation, pouring machine-gun fire into him at 100 yards. After a quick and decisive combat, the enemy leader fell out of control. Lieutenant Jones then attacked two of the other enemy planes, which were attacking him from the rear, and succeeded in driving them off. Home address: Mrs. A. H. Jones, Haywood, Alameda County, Cal.

First Lieut. Walter L. Avery, 95th Aerò Squadron. —For extraordinary heroism in action north of Château-Thierry on July 25. Home address: F. E. Avery, 1,199 Franklin Avenue, Columbus, Ohio.

First Lieut. Louis G. Bernheimer, pilot. Home address: Sidney Bernheimer, 138 72d St., New York City.

* * *

Lieutenant Alan Winslow Receives the War Cross

Lieutenant Alan Winslow of Chicago and Yale has recently been awarded the much coveted War Cross for conspicuous service while flying in France. This American airman is the son of a wealthy Chicago manufacturer and a member of the class of 1918 at Yale University. After two years of training he attracted the attention of the authorities by his fearless flying at the front.

In the air encounters just prior to the cessation of hostilities much was demanded of the antagonists. It was not sufficient for the airmen to be fearless and skilful in ordinary air maneuvers. His life depended upon his skill in performing feats in midair which a short time ago were considered merely circus stunts too perilous for any useful purpose. To out-maneuver and out-fight the Germans, the airman had to outmatch them in "looping the loop," in spinning nose dives and in all the feats of modern airmanship. Among the thousands of airmen flying at the front, Winslow distinguished himself and has been officially recognized for his skill.

Lieutenants Winslow and Campbell (the first American-trained aces) were near the front one day playing cards when the alarm was sent out that an enemy fleet of airplanes was approaching. The two airmen, running to their machines, leaped to their seats and rose to meet them. Each airman picked a Boche from the fleet and started after it.

Lieut Alan Winslow, the first American-trained ace to receive War Cross

The German was in full retreat when Winslow, using all the speed at his disposal, succeeded in overtaking his man. Seeing himself in danger, the German resorted to the desperate expedient of "looping the loop" at close quarters. The German machine succeeded in describing a circle about Winslow's machine which made it practically impossible for him to train his gun effectively, but by resorting to the same tactics Winslow finally succeeded in gaining a favorable position. When his aircraft had swung to the right angle Winslow fired with a sure aim and the German plunged down out of control.

The moment his enemy was disposed of Winslow turned and started to help Campbell, who was engaged in a lively battle in another part of the sky. Between them the other Boche was disposed of, and the rest of the fleet then retreated. The two Americans, communicating with each other by means of the radiophone had achieved their victory by cool teamwork. On landing after the battle the two Americans were the subject of an enthusiastic demonstration by the French aviators who had watched the battle from the ground.

Experimenters' World

A High-Speed Key of Unique Design

MORE amateur dreams of a high-speed sending key have been wrecked upon the rocks of mechanical difficulties that were insurmountable, than any other device that I know of. The prohibitive price of the manufactured article places it beyond the reach of the average amateur's pocketbook, and the complicated nature of the instrument prevents its successful manufacture in the average workshop.

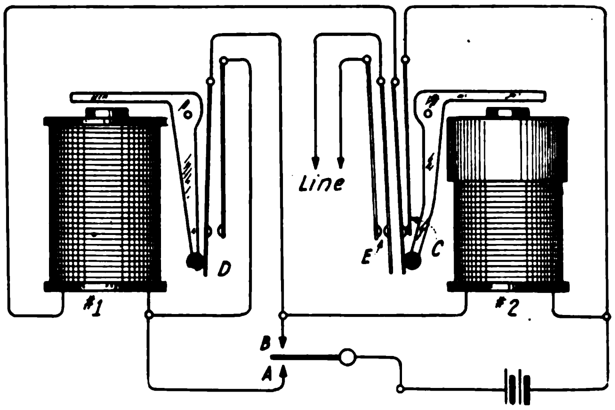


Figure 1—Showing the circuit of the high-speed key

I present herewith, however, an automatic key operating by an electrical slow acting relay instead of mechanical mechanism.

If we encircle an electromagnet with a closed copper ring of very low resistance, and if a current passing through the electromagnet is suddenly broken, there will be a secondary current induced in the copper ring which will in turn magnetize the core, thus tending to prolong the magnetic action.

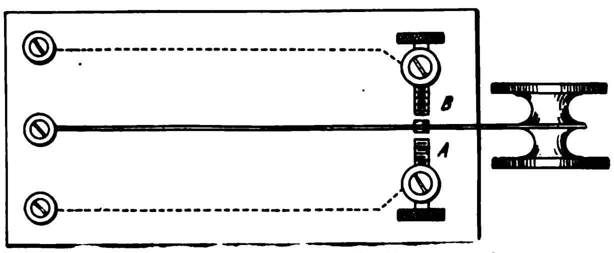


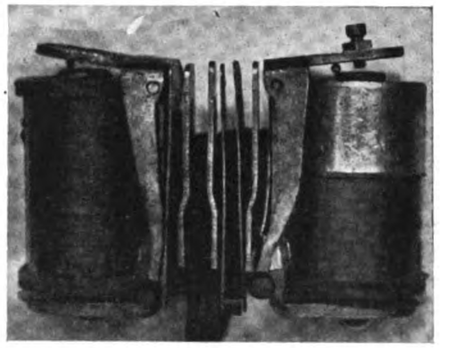
Figure 2—Simple form of the double contact key

This is precisely what is required for the electrical operation of our dot-making device in the high-speed key. In figure 1 is shown the circuit for the instrument, this consisting of a double contact key at AB, a battery and two electromagnets, number 1 being an ordinary magnet of about 20 ohms resistance, and number 2 being one of the slow-acting type just described. In order to give satisfactory results, the copper slug should be about ½" long and 1" in diameter, with a hole in the center of the diameter of the core.

The operation of the device is as follows: Closing the contact A allows the battery current to flow into coil number 1 through the contacts C. This pulls up the armature of number 1, closing contacts D, thus allowing current to flow into coil number 2, which in turn pulls up and opens contacts C, at the same time closing contacts E, which are connected to the main line. But the opening of contacts C releases coil number 1, thus opening contacts D and releasing coil number 2. This coil, however, requires an instant before releasing, which then starts the cycle over again.

The photograph shows such an arrangement as constructed by the author, using stock telephone relay parts, which was found to be entirely suitable. When sending at a speed of 20 words per minute, the speed of making dots varies from 8 to 12 per second; any variation of speed desired may be secured by adjusting the spring tension and the distance between the armatures and cores.

Figure 2 shows a simple form of double contact key to be used at AB. It consists of a steel corset stay rigidly fixed at one end, and making contact either with A for dots, or with B for dashes. Two key nobs are screwed to the other end for its manipulation, and it is operated just like the ordinary high-speed key. In using a key of this type, practice is required to get just the correct number of dots in each letter, but a few weeks are sufficient to make one fairly adept.



High-speed key apparatus constructed by using stock telephone relay parts

ARNO A. KLUGE—*Nebraska.*

A New Capacity Meter

THE objects of the apparatus herewith described are:

(1) To enable the capacity of a condenser to be very accurately and rapidly measured.

(2) To assist in the manufacture of condensers of a definite capacity.

(3) To enable variable condensers to be accurately and rapidly calibrated.

(4) It is intended as a useful instrument in the design of wireless apparatus.

The capacity meter depends for its action on the utilization of the phenomenon of "beating effects" produced by two sets of superimposed continuous oscillations. Continuous oscillations are set up in the grid and plate oscillating circuits of a vacuum tube by coupling the inductances. Another similar circuit is arranged with telephones included in the plate circuit.

If the frequency of the continuous oscillations in the first circuit A is made approximately equal to the frequency of the oscillations generated in the second valve circuit B, audible beats will be produced which will give a note in the telephones of the B circuit. The pitch of this note depends on the difference between the frequencies of the two sets of oscillations; that is, the note frequency heard is equal to the difference of frequency of the two sets of oscillations.

When the frequency of A is equal to the frequency of B, no beats will be produced, and therefore nothing

will be heard in the telephones. The moment the frequency of A is altered, however minutely, by altering the inductance or capacity of its circuits, a note will be heard in the telephones of B. If the difference of frequency of the oscillations in A and B exceeds about 14,000 per second, although beats are still produced, nothing will be heard in the telephones.

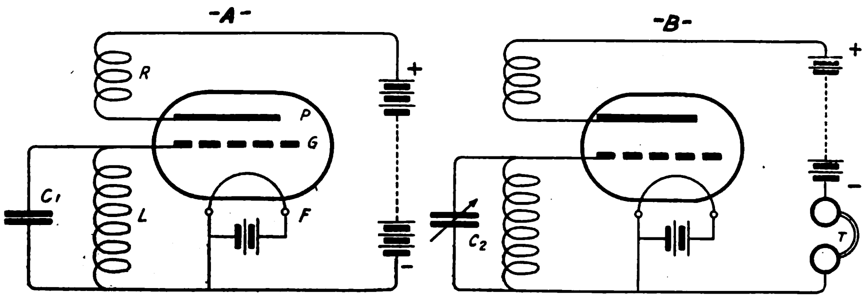


Figure 1—Diagram of two continuously oscillating circuits used in the capacity meter

The invention uses the phenomenon of the beating effects to compare the capacities of condensers. Figure 1 shows two continuously oscillating circuits A and B. These circuits might be mounted in a box. The circuit A may conveniently be oscillating at, say approximately, a frequency of 500,000 per second.

C_1 is a very accurate standard condenser of, say, .002 mfd. capacity. By varying the variable condenser C_2 the frequency of the oscillations taking place in B circuit may be altered on either side of 500,000. If the oscillations in B are of a frequency of 400,000 nothing will be heard in the telephone. As the capacity of C_2 is gradually decreased, the frequency of the oscillations in B will increase and a very high note will be heard, owing to the establishment of audible beats which are rectified by the vacuum tube. This high note will gradually become lower as the frequency of B approaches the frequency of A, namely 500,000 per second. When the frequency of B equals that of A, no beats will be produced. The graduation of .002 mfd. should be made on the condenser C_2. On still further increasing the frequency of the oscillations in B, a note will be heard again which will rise higher and higher and finally die out.

Several different standard condensers should be substituted for the condenser C_1, and in each case a graduation should be marked on the condenser C_2 when it is adjusted to such a position that a variation to either side will cause a note to be heard in the telephones. Intermediate graduations are then marked on the scale of the condenser. When the condenser C_2 has been completely graduated by means of accurate standard condensers, the instrument may be used for a variety of purposes.

To measure the capacity of a condenser of uncertain capacity, the condenser should be connected in place of the C_1 condenser of the A circuit. The condenser C_2 is varied until a "chirp" is heard in the telephones. The middle of this chirp is found so that a variation to either side would give a note in the telephones. The calibration mark of the condenser C_2 will then register the capacity of the condenser under test. This result will be exceedingly accurate. Even the alteration of capacity by placing the hand near C_1 will be indicated by hearing a note in the telephones, since the balance of frequencies has been upset.

If a condenser of, say, .0005 mfd. is to be constructed, the condenser should be made approximately of the correct size. It is connected in place of the condenser C_1. Its capacity is then measured by turning the condenser C_2 until the middle of the chirp heard is obtained. If the capacity is too high, the plates of the condenser should be reduced, and tests made until the capacity is exactly .0005 mfd.

A variable condenser may be calibrated as follows:

Connect the variable condenser in the position of C_1. Make a number of calibrations by balancing C_1 and C_2 as described, calibrating C_1 with the readings given by C_2. The accuracy is exceedingly high since the slightest difference of capacity is indicated by an alteration of the note.

The procedure for measuring the capacity of large condensers is somewhat different. When the capacity of a large condenser is to be measured, a small standard condenser would be included in the instrument and would be connected in series with a large condenser. A separate calibration chart would be provided with the condenser C_2. When measuring small capacities the standard condenser would be connected in parallel.

Lieut. J. Scott Taggart—
Great Britain.

A Satisfactory Lead-In

THE following is a satisfactory method of bringing the aerial lead-in into the radio room where it is undesirable to drill through the window frame. A pane of glass is removed from one of the sashes and one corner is cut off; then it is replaced and a thin piece of either wood or fibre, drilled to pass a porcelain bushing, is fitted into this space in the corner of the sash. It is fastened in with brads and putty the same as the window pane. This bushing consists of two tubes placed inside of one another with pitch run in between. The wood or fibre corner should be well varnished to prevent warping. It will also be well to provide a small drip shield cut from sheet metal and soldered to the conductor near the point where it enters the bushing to prevent the beads of rain from following the lead-in into the room. Figures 1 and 2 are self-explanatory.

J. A. Wever—*Maryland.*

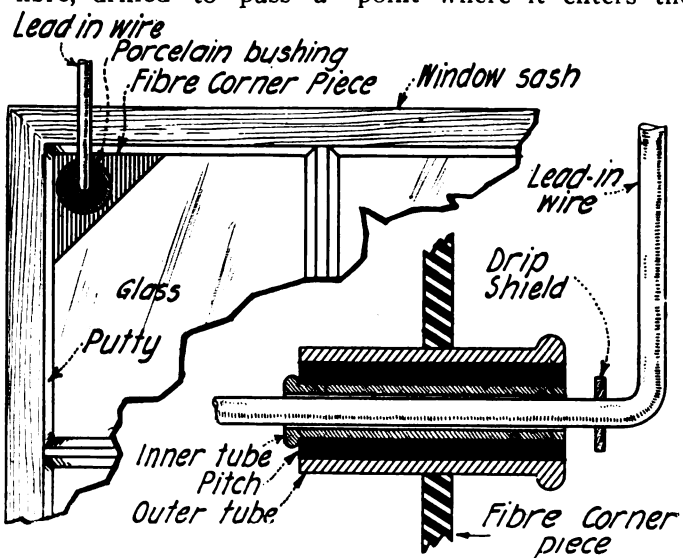


Figure 1 (upper left) and figure 2 (lower right) illustrate the construction and application of the aerial lead-in

A Unique Life Preserver

THE accompanying drawings and photographs show the use of a novel life preserver suit, which, in addition to the one wearing it, can support five others in the water. Never before in the history of the world's progress has there been such an imperative need for a life

High seas, cold weather, vast distances have no terrors for these men when protected by the safety-suit whose buoyancy is sufficient to support six persons in water

saving device that is thoroughly reliable. New dangers, added to the old, startle one daily with the toll taken of men, women, and children who travel by ship. Not alone the ocean, but coastwise waters, lakes, bays, and rivers are claiming an ever-increasing human price as boats multiply and high power and greater speed is developed, until many dread to plan a voyage or to think of loved ones and friends going on yachting cruises, motor boat trips, or even on river excursions.

The safety-suit illustrated is a self-guarantee against nautical disaster and accident. It makes drowning almost impossible and protects the wearer from exposure and its after effects. It keeps the shipwrecked traveler afloat for hours and days. It is a one-piece garment, perfect in workmanship and mate-

On land again after a sojourn in the cold waters of New York Bay in November

rial, and can be put on by man, woman, or child in less than a minute.

Little has been done to insure the safety of passengers in the event of disaster, during the hours which may elapse between the sinking of a ship and the arrival of assistance. The open boat, the life raft, and the primitive life preserver are the devices to which the traveler must turn when the ship fails him. The history of marine disasters has demonstrated that the launching of boats under stress is a hazardous undertaking at best and often is made impossible by the list of a sinking ship, a rough sea, or damage to the boats themselves. The life raft, washed by every sea, is a makeshift; and the final dependence of the passenger must be placed upon the individual life preserver.

It is often asked, "Has the life preserver made good?" Experience proves that it has not. Let us suppose that you are aboard a sinking ship. A wireless call for help has been sent broadcast over the ocean, and, a hundred miles away, a steamer turns about with smoke pouring from her funnels, while her wireless crackles a message of hope. There is barely time to adjust a life preserver, gather a few of the most precious possessions and scramble up to the tilted deck, when one finds oneself afloat—submerged to the neck in icy water. Before help can be secured several hours often elapse—several hours of exposure such as no human being can live through.

In addition to keeping one afloat, it is agreed that an effective life saving device must keep the body warm and dry in water for an indefinite length of time; it must keep the body upright with head well out of water; it must be quickly adjustable and proof against accident that might render it ineffective; and it should be compact, light and easy to carry. The safety-suit illustrated is a device which answers fully all of these requirements.

It enables the wearer to remain afloat for an indefinite length of time and to emerge warm and dry, notwithstanding cold water, rough sea, and strong wind. It contains a pocket large enough to carry a canteen and liquid food to last the shipwrecked 48 hours and more. It affords abundant space in which to carry valuables or papers, with the assurance that they will remain dry and safe, whether in the pockets of one's clothing or otherwise placed within the suit. It is equipped with a shrill whistle, readily accessible, with which to help attract the attention of rescuers. It embodies every device that human ingenuity can suggest to insure safety while in the water.

The suit is made in union style, with shoes and mittens, all in one piece, completely enclosing the body, excepting the head, in a water-tight garment.

Meters for Wireless and High-Frequency Work

A HIGH-GRADE, hot-wire measuring instrument designed particularly for wireless and other high-frequency work, depending for its operation upon the expansion of a

Switchboard ammeter

metal strip which is heated by the current to be measured has been developed by the Westinghouse Electric & Mfg. Co. The slight sag in the conducting strip is magnified several hundred times on the scale by means of a combination of wires and a deflecting spring.

The conducting strip is made of special non-corrosive material. The separating posts have the same temperature co-efficient of expansion as the conducting strip, so that the changes in room temperature do not cause an error in the reading of the instrument.

The flush-mounting form, known as type EH is of the round open-face type. The face is 3 inches in diameter, and the diameter outside the flange is 3¾ inches. It has a black rubberoid case and rim, with white dial.

The portable form, known as type PH, is mounted in a Morocco leather-covered wooden case with heavy glass over the dial. The case is 3¾ inches by 4⅜ inches by 2 inches thick.

The scale plate is made of metal, and the scale subtends an arc of 90 degrees, being 2⅜ inches long.

Portable ammeter

The type EH meters have a guaranteed accuracy of 2 per cent, while the type PH, with hand-marked scale, can be expected to show an accuracy within 1 per cent of full scale. Standard meters are for 1, 2 and 5 amperes. Care must be used not to subject the instrument to more than 200 per cent load.

The Monthly Service Bulletin of the NATIONAL WIRELESS ASSOCIATION

Founded to promote the best interests of radio communication among wireless amateurs in America

A Recount of Past Performances of Amateur Stations

NEITHER the general technical public, nor even the average member of the Institute of Radio Engineers, knows what consistent long distance work was done by a number of amateurs throughout the United States, working under the double handicap of low power and short wave lengths.

During the 1916-1917 radio season the amateur field underwent some great changes, due partly to the adoption of the short wave regenerative sets, which for some reason had not up to that time come into general use.

The first amateur relay organization which pointed the way for the record breaking relays which developed throughout that season, was the American Radio Relay League. Trunk lines were organized through the larger cities of the United States for the purpose of establishing routes over which messages could be dispatched with regularity and rapidity. The main trunk line from New York City to Los Angeles, Cal., ran through Albany, N. Y., St. Marys, O., Chicago, and thence south via Nattoon, Ill., and branched to the coast either through trunk line "E": Little Rock, Ark., Dallas, Tex., Phoenix, Ariz., and Los Angeles—or trunk line "G": Jefferson City, Mo., Kansas City, Mo., Denver, Colo., and Los Angeles.

The relay station 2ZL (2LK) at New York handled some 1,300 messages during the season, most of which were messages over these lines. The Chicago 9ZN station handled 650 and 9ALM, his assistant, 425; station 6EA at Los Angeles relayed 520 messages; 99BD at Jefferson City, Mo., 300 messages; 1ZM at Hartford, Conn., 217 messages; 9EP, one of the Kansas City, Mo., stations 200 messages; 9ZK, another Kansas City station, 150 messages; station 8ASG, at Eaton, O., relayed 110, and so on down the line.

Probably the most efficient eastern station was station 2PM operated by Faraon and Grinan at New York City. On a wave of 200 meters with 450 watts input to the transmitter, 2PM repeatedly worked stations as far west as 8AEZ, 8NH, 99BD, 9ZN, 9ALM, 9XM, 9LR, 9GY, 9HQ.

Coming a little further west, station 2AGJ at Albany, N. Y., did remarkable work; using 750 watts input he worked with 9ABD, HCL, 9LR, 9ZK, 9ZN. Boats off Key West (9ZN) reported his signals audible often thirty feet from the phones.

Next 8AEZ and 8NH about share equally the honors—8AEZ at Lima, O., and 8NH at St. Marys, O., have both been reported at Phoenix, Ariz., a distance of about 1,600 miles. Few indeed are the amateurs east of the Rockies who have not heard both these stations.

Then 9ZN at Chicago, Ill., was heard quite regularly from the Atlantic Coast to the Rockies and one night worked with 7EG at Baker, Oregon. Mr. Matthews used a 1-kw. key set and at the time was working on 425 meters. The same night he was reported at 6F9 at Los Angeles, Cal.

Also 9ALM at Chicago, and 9AV at Maywood, Ill., did remarkable work.

Coming south, 9ABD at Jefferson City, Mo., probably leads. He was heard on the four boundaries of the country and worked boats off Key West. Ranking about with 9ABD, are 9LR at St. Louis, 9EP and 9ZK at Kansas City, and 9LQ at Lawrence, Kan.

9GY at Nattoon, Ill., has been heard on both the coasts. 9GY handled a very large amount of traffic from the west and southeast through 29GJ at Albany.

In Dallas, Tex., were two very efficient relay stations, SZC and 5DU. Both have been heard on all the boundaries of the country and have been responsible for the successful relaying of a large amount of traffic.

4AA at Athens, Ga., did very good long distance work on about 450 meters using very low power.

5ED at Houston, Tex., has been heard at Philadelphia and Albany, N. Y., and New York City. He was also heard at 6ZQ at Phoenix. 4CL at College Park, Ga., did very good work, working with stations far north.

Further east was the very efficient station at Denver, OZF, who was mainly responsible for the handling of transcontinental work. 9ZF often

Suggestions for the Experimenters' World

We will pay the usual prizes of $10, $5 and $3, in addition to our regular space rates, to the three contributors who send us the best manuscripts on the following subject:

AT THE FINAL CONCLUSION OF PEACE NEGOTIATIONS, WHAT DO YOU CONSIDER TO BE THE MOST IMPORTANT REASONS FOR IMMEDIATE OPENING OF AMATEUR WIRELESS STATIONS?

This subject can be treated from the viewpoint of the beneficial services which trained amateurs gave to the government during the war or from any other logical, consistent standpoint.

Another suggestion for a forthcoming issue:

WHAT RESTRICTIONS SHOULD BE IMPOSED UPON AMATEUR TRANSMITTING SETS IN RESPECT TO POWER INPUT AND WAVE LENGTH?

Limit your manuscript to 800 words.

worked 8AEZ, 8NH, 9ZN, 9ABD and is reported as working 2PM at New York one night. Another good station at Denver was 9AMT who handled quite a few messages. 6ZQ (6DM) at Phoenix, Ariz., did fine work, having worked 9ALM and 9ZN at Chicago. He has reported also hearing thirty-one stations over 1,000 miles from him.

And last, but not least, comes 6EA at Los Angeles, which worked up and down the whole state of California, who was heard at Juneau, Alaska, 9ADL, Milwaukee, Wis., Houston, Tex., Little Rock, Ark., (1,800 miles) and by the SS D. G. Scofield (WDR) 1,289 miles out of San Francisco for Hong Kong.

There are numerous other amateurs who have piled up "records" of 1,000 miles transmission. Among this number are:

1ZL, Northampton, Mass.
1ZM, Hartford, Conn.
5ZM, Mobile, Ala.
8XA, Ann Arbor, Mich.
8U1, Pittsburgh, Pa.
8UL, Lima, O.
8YO, Columbus, O.
8ZJ, Buffalo, N. Y.
8XM, Madison, Wis.
9YG, State Agricultural College, N. Dak.
9Z1, Louisville, Ill.
3RO, Danville, Va.
4D1, Winston-Salem, N. C.
5AM, Birmingham, Ala.
5AX, Shreveport, La.
5BB, Franklinton, La.

8AAK-8CS, Saginaw, Wis., and many other 8th and 9th district stations.

These records have been due usually to the fact that the oscillatory circuits of the transmitter were correctly proportioned and carefully tuned. At the receiving end some form of the Armstrong circuit, either a Paragon, Grebe or home-made regenerative set was employed.

JOHN M. CLAYTON—*Arkansas.*

Spying on Germany in the Early Days

A RECENT article in THE WIRELESS AGE stated that wireless operators on American and other ships crossing the ocean, frequently pick up orders being sent by the German Admiralty to their submarines at sea, from the Nauen Station (POZ) in Germany. many.

For about a year before our stations were closed by the Government, I would hear every evening at 6:50 P.M. here (12:00 M. in Germany) the same messages, giving instructions to all of the submarines which came to the surface at that time in order to receive the signals. Their messages were all in cipher, different from our cipher, for they consisted of numerals and letters combined.

For the time signal, in place of the "ticks" sent out by Arlington (N A A) they used letters, G. G. G. O. O. O. X. X. X., etc. Just at 12:00 M. they gave a long dash similar to Arlington.

They evidently changed their cipher every few minutes, as they would say, Groupen 26, then Groupen 28 and so on.

WM. H. SEABURY—*Brookline, Mass.*

This is the first information we have received concerning the methods employed by the Germans in sending time signals. No transatlantic vessel could take down the signals from Nauen unless its equipment included an undamped wave receiver of some type. With a vacuum tube regenerative beat receiver, no difficulty would be experienced in copying signals from POZ, but it must be remembered that the average vessel is not equipped with a 10,000-meter tuner.

Results Obtained by Station "CV" (Houston, Texas) Before the War

THIS article I hope will renew pleasant memories of the hours spent by amateurs in long distance working just before their stations were closed down by government order.

Of course, most every amateur believes that he was doing the best work or had the best set at that time. I, for one, obtained most excellent results at my station and many were the nights that I closed "shop" at 4:30 A.M.

My station, being located at the extreme southern point of the United States, will no doubt make the results obtained in the South most interesting to those of the East, North and West who were also engaged in the same work.

As a whole I would say the conditions are most favorable to radio communication in the South; in fact I believe better conditions do not prevail anywhere. However, other locations may be equally good, but I doubt if it can be proven that the-so-much-thought-of Pacific Coast can equal Texas for favorable radio work.

The country is flat and a good portion is covered with trees, many towering seventy-five to ninety or even one hundred feet in height. The soil is of a somewhat sandy texture and is found to be damp about three feet below the surface, most any season.

It will be interesting for those who were in amateur work before the war, to review what was done at CV and to help keep the amateur radio spirit up so that when the war is over all the "old boys" may be able to lay aside war work and again plan to establish better records. I will record some of the best amateur transmitting and reception records together with a list of the stations heard during the period between January, 1917, and the date when my station was closed.

My very best working record made was by communicating directly with 9XN (University of North Dakota, Grand Forks, N. D.). This is a distance of 1,315 miles, air-line, and this station was worked twice within one week. No difficulty was experienced in holding conversations. On one occasion I worked both ways above five times. I hardly believe the operator in charge was aware he was working a station on the Gulf of Mexico, but if he reads this he will realize the fact. As I was not using a government call, his first inquiry after answering my call was Q R A (what station is that)? I answered back "Houston, Texas." He replied "only Houston, give me your address OM." I told him he was working with an amateur in Houston, Texas, and would give him my name if he cared for it. He would not believe this and finally quit, with the impression that someone was kidding him.

Other places where my signals have been heard are Albany, N. Y., 1,540 miles—a record distance. Superior Wis., Los Angeles and other southern places of California, Jacksonville, Fla., and Tampico, Mexico, were worked.

In amateur reception four different stations were heard that were over 1,600 miles distant (all of Northern California), and three of the four, namely, 6BY, 6KU and 6FG were heard a number of times, sometimes every night for a few nights and then only at intervals.

The amateurs of California were heard best from about 11.30 P. M. until about 3.30 A. M. There invariably seemed to be a marked "peak" in the strength of the signals from the California amateurs between 11.20 and 11.50 P. M., and again between 2.25 A. M. and 3.30 A. M.

One other thing was noted: the stations of the 6th district (California) were often heard at their twilight hours, but owing to the hubbub of Q R M it was never possible to listen to a given signal for any length of time, as someone invariably jammed it.

During the entire season five amateurs of Los Angeles were heard, some

of them were heard with regularity, others just occasionally. 2AGT of Albany, N. Y., was heard twice during the season, but strange to state no other station of the second district was heard, and none of the first and none of the third.

At various times testing was carried on with other amateurs 600 to 900 miles distant, and interesting observations were made. For example, I was able to transmit 880 miles (9PI Indianapolis, Ind.) using but 106 watts input, or roughly speaking, 1/10 kw. power. On high power my input was 445 watts and on low power (used for local work) the transformer drew 106 watts. I was not the only one who could pull stunts like that, as I could hear 9ABD (Jefferson City, Mo., 650 miles distant) on his low power. I don't know his exact power consumption. Also I could hear 9PI when on his lowest power, as well as 9GY of Mattoon, Ill.

In receiving work, various apparatus was used at different times, but a regenerative hook-up, using a small sized home-made coupler that would tune to about 500 meters, with a variable condenser in series with the primary circuit, gave the best results. All connections were soldered, even the connections to the telephones, condensers, etc. This alone increased the signals. In the transmitting set all connections were soldered wherever possible and all conductors were of low resistance and sufficiently large to insure proper conductivity. The transformer used for this work was oil immersed and home-made, but of good construction and drawing 445 watts on *high power.*

The antenna mast was 76 feet high and constructed of 4 x 4's and 2 x 4's, and well guyed. The other end of the antenna was supported by a tree about 60 feet in height. The antenna was 90 feet long and consisted of seven No. 8 copper wires, with lead-in taken at the high end. The insulators used were 16 inches long and one inch in diameter, of hard rubber.

Queries Answered

Answers will be given in this department to questions of subscribers, covering the full range of wireless subjects, but only those which relate to the technical phases of the art and which are of general interest to readers will be published here. The subscriber's name and address must be given in all letters and only one side of the paper written on; where diagrams are necessary they must be on a separate sheet and drawn with India ink. Not more than five questions of one reader can be answered in the same issue. To receive attention these rules must be rigidly observed.

Positively no Questions Answered by Mail.

R. M., Findlay, Ohio:

About one-half ampere of antenna current is all you may expect from the spark transmitter mentioned in your first query. Keep in mind that during the period of the war, amateurs cannot construct or experiment with wireless apparatus.

Regarding your query No. 2: The insulation of ordinary wood is sufficient for receiving aerials, but not feasible for transmitting apparatus on account of the high voltages involved.

In respect to the purchase of dead-end switches: We know of no manufacturer that can supply you with these switches for the time being, but they can be quite readily constructed.

* * *

A. T. H., Albert Lea, Minn.:

We have no information regarding the possibility of the reopening of amateur wireless stations after the close of the present war. As we have stated time and time again in these columns, amateurs cannot construct or experiment with radio apparatus during this period.

Regarding your third and fourth queries: We know of no manufacturer that will supply you with end turn switches for receiving tuners.

In reply to your fifth query: It makes no difference how the coupling is varied between primary and secondary circuits of the receiving tuner. Any feasible mechanical construction can be employed.

* * *

H. H., Atlantic City, N. J.:

Any of the text-books on radio telegraphy issued by the Wireless Press will show you how to connect a stopping condenser in a receiving circuit. In the usual receiving circuit, a crystal detector and a head telephone are connected in series, and in shunt to the terminals of the secondary condenser. In this case the stopping condenser is in reality a telephone condenser being placed in shunt, in order to obtain an accumulative effect of the rectified current.

On the other hand, in the old carborundum hook-up, as shown in figure 153-A of "Practical Wireless Telegraphy," it is necessary to insert a condenser in series with the crystal detector to prevent the battery being short-circuited by the secondary windings of the receiving transformer. This condenser is of fixed capacity. On the other hand, the diagram in figure 153-B of "Practical Wireless Telegraphy," when used in connection with the crystaloi detector, gives satisfactory results only by providing a telephone condenser of very large capacity. There is nothing unusual about the construction of this condenser. It may either be adjustable by steps or continuously variable. It can be made of a number of interleaved sheets of tin foil separated by paraffine paper. By the use of a multi-point switch, taps can be taken so as to vary its capacity.

The most effective results are obtained from dry batteries for the operation of a spark coil when a series parallel connection is employed. Connect up enough series cells to provide the requisite voltage for operation of the induction coil. Then make up another group with the same voltage as the first and connect them in parallel with the first group. This connection will tend to prolong the life of the batteries.

No advantage is derived in the use of a rotary gap in connection with the spark coil, for the note of the spark discharge

is already governed by the frequency of the interrupter. The only advantage that could possibly be derived from a rotary gap would be to mount it on the shaft of a mechanical interrupter and operate it in synchrony therewith. Such a method has already been described in an issue of THE WIRELESS AGE.

It would be well for you to keep in mind that amateurs are not permitted to experiment with or construct wireless apparatus during the period of the war. They will open themselves to suspicion by so doing and are subject to a penalty for any violation of the President's executive order.

* * *

G. E. W., San Francisco, Cal.:

We are unable to give you a satisfactory explanation to account for the burning out of your high voltage transformer. It may be that one of the secondary coils was too close to the iron case and, in consequence, an arc was set up on account of the difference of potential between the frame and the windings. If we were on the ground and could make an examination of the general conditions surrounding your apparatus, we would be able to give a satisfactory explanation. However, the inspector in your home port will solve your problems for you.

The burning of the collector rings on the generator probably is due to the fact that the rings are bent so that the brushes arc as the collector rings rotate.

* * *

A. B. D., Boston, Mass.:

The grid and plate circuits of a cascade vacuum tube amplifying system can be coupled through a resistance, an inductance or condenser. Satisfactory circuits have been evolved for all three methods of coupling. The plate circuit resistance for coupling is usually of the order of 20,000 ohms, more or less, depending upon the resistance of the vacuum tube.

A. F. S., Radio School, Harvard University:

You will find on page 198 of the book, "Radio Instruments and Measurements," issued by the Bureau of Standards, a decrement scale which can be trimmed off and applied to any variable condenser with semi-circular plates, which is an element of a wave meter circuit.

In contrast to the simple variable condenser whose capacity increases linearly with the rotation in the movable plates, the condenser in the Kolster decremeter is designed so that the per cent. change of capacity is the same throughout the entire range of the condenser and equal angular rotations on any part of the scale correspond to the same decrement. This is obtained from special design of the moving plates.

In the Kolster decremeter, the decrement scale is geared to the movable plates of the variable condenser. The decrement is measured as follows: The wave meter is first tuned to resonance by observing the maximum reading of the ammeter. Then the capacity of the wave meter condenser is increased to some value above resonance where the reading of the hot-wire ammeter is one-half of that obtained at resonance. A sliding ring encircling the decrement scale is then turned so that its zero point coincides with the zero point on the decrement scale. The capacity of the wave meter condenser is then decreased to some value below resonance where the reading of the ammeter is again one-half of that obtained at resonance. The notation on the decrement scale underneath the pointer (which has now turned through a certain number of degrees) gives the combined decrement of the wave meter and that of the circuit under measurement. The decrement of the decremeter being known, it is subtracted from the reading obtained as just described.

Electrical Digest

The Improvement of Power Factor by Use of Static Condenser—A Novel Method for Illustrating Electric Phenomena—Research on Searchlights

The Improvement of Power Factor by Use of the Static Condenser

MEANS for improving the low power factor encountered in alternating current power circuits have been given more and more consideration as the use of alternating current power machinery expands. The wattless current resulting therefrom is by no means wattless when figured back to the coal pile, for in such circuits the consumption of coal is required even though no power is derived from the wattless component. War-time economy demands the adoption of devices for improving the power-factor to as near unity as possible.

The lagging phase in alternating current circuits has heretofore been corrected through the use of the so-called synchronous condenser — a machine admirably adapted to this work on power lines in which the conditions are constantly changing, but in many small installations the first cost of such a machine is prohibitive.

Extensive use has been made, of late, particularly in Europe, of the static condenser, which has proved a boon to small power installations where the character of the load is more or less constant. The principal disadvantage of the static condenser compared with the synchronous condenser, is its lack of flexibility, but it possesses several real ad-

vantages, chief among these being its efficiency, which approximates 99 per cent. Again, its first cost is low; it occupies less space than the synchronous condenser; there is a complete absence of vibrating and rotating parts, and when once installed it requires little or no attention. The reduction of the output of generators, transformer and distributing feeders, as well as the increase in heating losses and bad voltage regulation resulting from low power factor loads, have been experienced by all central alternating current power stations.

The static condenser manufactured by the General Electric Company in the United States consists of a number of condensers mounted closely together to form a compact unit. Each condenser is composed of paper and metal foil submerged in oil and assembled in metal containers.

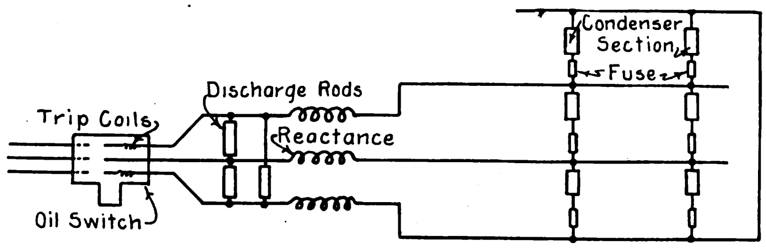


Figure 1—Schematic diagram of rtatic condenser, showing control, discharge rods, reactance, fuse and condensers

We are indebted to a recent issue of the Electrical Review for a wiring diagram and data on the static condenser as used in typical installations. The accompanying diagram shows the three-phase installation designed by the General Electric Company.

It is pointed out that if a static condenser be connected directly across the power line, it will generally be found that instead of raising the power factor, it lowers it. This is due to the fact that a condenser tends to amplify the harmonics in the voltage wave so as to interfere with the expected increase in power factor. To overcome this and to damp out objectionable harmonics, the reactance coils shown in the diagram are connected in each phase.

The resistance or discharge rods shown in the diagram serve to discharge the condensers immediately they are disconnected from the line. As a prevention against short circuits, fuses are connected in the circuit. The trip coils controlling the circuit breaker are installed to permit disconnection of the condenser should anything occur to make it advisable for the units to clear themselves from the line.

The effect of low lagging power factors on power lines are aptly illustrated by the following example:

A 100-kva. transformer will deliver 100 kw. at unity power factor. Assuming, however, that the power factor should lag .60, then the rated energy output of the transformer would be but 60 kw. and yet the current and consequently the heating would be approximately the same as when delivering 100 kw. at unity power factor.

The ill effects of low power factor loads on alternating current generators are more striking than on transformers, for they have decreased kilowatt capacity, decreased efficiency, impaired voltage regulation and, in addition, call for increased exciter capacity. In the case of a 200-kva. dynamo designed for .08 power factor (160 kw. output), if the power factor in the circuit is but .60 it is probable that the normal voltage could be obtained only with difficulty even though at this power factor the generator would deliver but 120 kw., and beyond this the lagging or current in the armature sets up a flux which opposes the flux set up by the fields tending to demagnetize them and thereby decreasing the armature voltage. In such circuits it is often necessary to install new exciters to supply an increased exciting voltage to the field coils. The field losses and therefore the field heating are greater at lagging power factor than at unity.

The Electrical Review offers a concrete example of the effects of low power factor in a circuit. Assume that a two-mile power line is to carry a 3-phase 60-cycle load of 160 kw. at 2,300 volts; sections of 25,000 circular mils at 100 per cent. power factor, 30,820 circular mils at 90 per cent. power factor and 69,500 circular mils at 60 per cent. power factor. It is, therefore, evident that the investment in copper must necessarily be 2.8 times as great for a power factor of 60 per cent. as for a 100 per cent. power factor. Also the energy losses will be 2.8 times greater, being actually 28 per cent. instead of 10 per cent. at unity power factor. This simple problem emphasizes the necessity for a high power factor in order to attain an economical investment in materials.

Before undertaking the installation of a static condenser for increasing the power factor a complete survey of conditions should be made to determine to what extent the problem of lagging current could be remedied by it. It is desirable, for example, to locate the static condenser as near the source of the inductive load as possible in order to avoid the transmission of wattless current. It is more economical to install a number of relatively small condensers rather than a single large one. It is for this class of service that the static condenser is especially suited. Just how the size of the condenser may be determined on a given line to raise the power factor to a given value is illustrated by the following example given in the Electrical Review. Reference is made to the curve in figure 2.

Assume a 250-kw. load at 0.60 power-factor, and that it is desired to raise to 0.90 power-factor.

A 250-kw. load at 0.6 is $250 \div 0.60$ or 416 kva. apparent load which has a wattless component lagging of $\sqrt{416^2 - 250^2} = 332$ kva. A 250-kw. load at $0.90 = 250 \div 0.9$ or 279 kva. apparent load that may be expected when the condition of 0.90 power-factor is realized. This has a wattless component lagging of $\sqrt{279^2 - 250^2} = 123$ kva. The difference $332 - 123 = 209$ is the leading kva. that will be necessary to raise to 0.90 power-factor.

This may be read directly from the accompanying curve. Read up the vertical line at 250 kw. energy to the point where it crosses the 0.60 power-factor line. The apparent load may be read as 415 kva. approximately. Reading from this point to the left margin the wattless component will be found to be 330 kva. Then in the same manner the apparent load at 0.90 power-factor will be found to be 280 kva. and the wattless component read at 125 kva. The difference or $330 - 125 = 205$ kva. which is close enough for all practical purposes to a 200-kva. condenser, the nearest standard size.

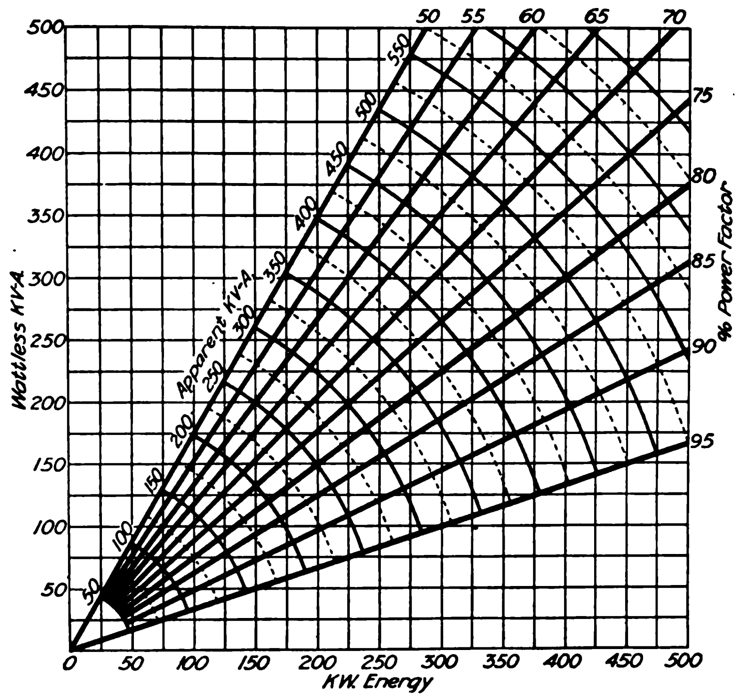


Figure 2—Curve showing relation of energy load to apparent load and wattless components at different power-factors

It will also be found in this case that using a 200-kva. static condenser will make it possible to take on an additional load at 87 kw. at 60 per cent. power-factor and still have the same total apparent load while the resulting power-factor would be 81 per cent. In other words, the possible income from the particular feeder in question may be increased $87 \div 250$ or approximately 35 per cent.

The success with which the static condenser can be used to correct low power-factor conditions, on even most extensive distribution systems, or on shorter lines and isolated plants should appeal strongly to every central-station manager, and to those in charge of isolated plants having inductive loads. Their use may in many cases obviate the necessity for additional generator, transformer, and line capacity and will always conduce to maintenance at the highest possible efficiency the generating plant and distribution system.

A Novel Method for Illustrating Electric Phenomena

C. H. BISHOP, of Rochester, N. Y., is the originator of several novel ideas for demonstrating the general phenomena of the electrical circuit. For example, he pictures a flow of current in parallel conductors by partly filling in the space between the wires. Different degrees of magnetization, for example, are indicated by parallel lines of varying density.

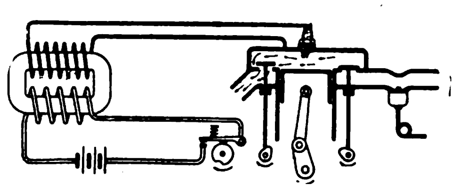


Figure 1—Ignition circuit of internal combustion engine

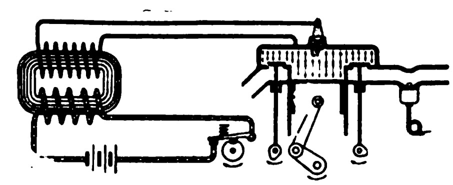


Figure 3—Battery circuit closed

An example of his work is shown in the accompanying diagrams, which indicate the ignition circuit of a gas engine and the functions performed during a complete cycle.

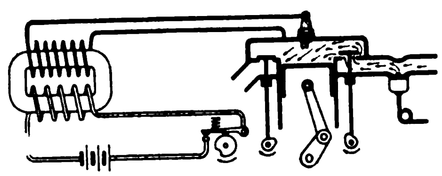


Figure 2—Circuit during intake of engine

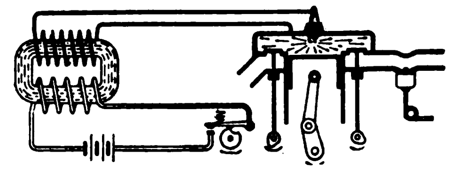


Figure 4—Secondary circuit discharged through spark plug

Thus in figure 1, the engine is exhausting, the intake valve being closed. The circuit breaker of the primary of the induction coil is open. In figure 2, the engine is on the intake stroke, the exhaust valve being closed, and the circuit breaker of the induction coil is still open. In figure 3, the intake valve and exhaust valve of the engine are closed and the charge taken in on the intake stroke is now being compressed. It is to be noticed that the primary circuit of the induction coil is closed as indicated by the darkened line.

In figure 4, the piston is nearing the dead center, the circuit breaker on the primary of the induction coil is open, the magnetic lines of force in the core of the coil are collapsing and the high voltage current flows through the secondary coil as shown by the darkened line. A spark is now discharging across the spark plug and a moment later complete combustion will take place in the cylinder. Afterward the cycle of operation will be repeated.

The diagrams should be of particular interest to aviation students.

Research on Searchlights

LABORATORIES having proper facilities to carry on extensive research with arc searchlights are urged by the Corps of Engineers, United States Army, to make investigation of the following problems and present solutions. The results of such investigations should be sent to the Officer in Charge, Searchlight Investigation, General Engineer Depot, Corps of Engineers, United States Army, Washington, D. C.

Data is desired on the following:

(a) Means for determining the finding power of a searchlight which will take into account the color of the light, the nature and color of the target, the condition of the atmosphere, and the distance between the searchlight, the target, and the observer.

(b) Means for **rapidly** determining the intrinsic brilliancy of a searchlight light source.

(c) A **simple** system of remotely controlling the operation of a searchlight in azimuth and elevation. The present or proposed systems require from five to fifteen or more wires, and are too complicated.

(d) A mirror design which shall be more efficient for anti-aircraft service than the standard parabolic mirror.

(e) A light source which shall be more efficient than a high-intensity carbon arc. A thallium arc has been suggested because it has only one line (green) in the spectrum.

(f) A mirror material which shall have the reflecting and longevity properties of silver-backed glass, without the fragility of glass mirrors.

Progress in Radio Science

(*Continued from page* 14)

separate lead 5′ sealed into the stem 6 of the device. By this construction the starting filament is located a greater distance from the anode 9 than the arcing tip of the cathode, in order to guard against the arc deserting the tip 3 and running to the starting filament either entirely or in part.

The anode 9 may have any convenient shape and may consist of refractory material such as tungsten or carbon, or volatilizable material such as mercury, as shown at 10 in figure 3. In a rectifier the anode should have a materially greater

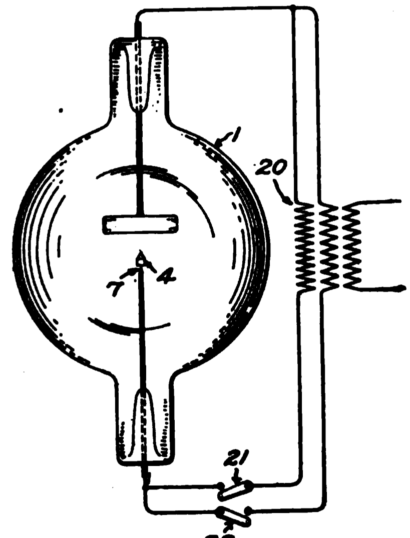


Figure 2—Modification of figure 1, with standing filament omitted and arc started by high-voltage discharge from a pointed cathode

heat dissipating capacity than the cathode, to enable it to remain below a temperature of about 700° C. at the normal operating current of the device.

In the preparation of the rectifying tube, the space within the envelop should be carefully exhausted of all gases and vapors, care being taken to remove electro-negative gases, such as oxygen or chlorin, or substances yielding electro negative gases, such as water vapor. A trace of oxygen does little harm when the electrodes consist of oxidizable metal, such as tungsten or molybdenum, as the oxygen combines chemically with the heated electrodes to form non-volatile oxids. The envelop is filled with a gas inert to the electrodes, as, for example, argon, nitrogen cryptom, neon, hydrogen, at a pressure which may be between several millimeters and atmospheric pressure, or more. These gases should be substantially free from electro-negative gaseous impurities. For low voltage rectifiers a gaseous pressure of 5 to 12 millimeters of mercury is desirable, but no definite limit of gas pressure can be given, as it will in general vary with the voltage upon which the device is operated and the character of the service required of the device. In some cases the gaseous filling may be constituted by the vapor of a material ordinarily a liquid; mercury for example. The envelop should be properly proportioned with respect to the energy consumed during the operation of the device to dissipate heat at a rate which will result in an operating temperature at which the vaporizable material has the desired vapor pressure.

The arc is started by heating the filament 8 to incandescence by suitable current introduced through the leads 5, 5′ by the conductors 11, 12, from a convenient source, such, for example, as the secondary 13 of a transformer 14. When the filament has been heated to incandescence, a current of suitable voltage is impressed between cathode and anode. As shown in the drawing, the device may be used to rectify alternating current supplied from the transformer secondary winding 15 through conductors 16, 17. The arc initially runs from the incandescent filament 8 to the anode and serves to heat the starting tip 3 to incandescence, both by heat conduction

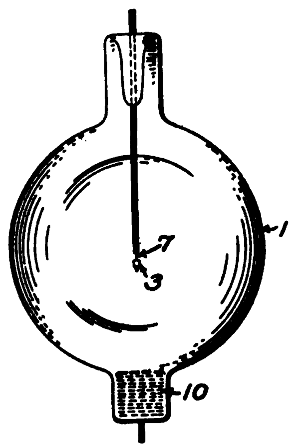


Figure 3—Tube having a mercury anode

from the filament which is connected to the tip, and by reason of the proximity of the tip of the arc as well as the heated filament. The circuit of the starting filament may then be opened by a switch 18. The arc will continue to operate from the incandescent tip 3 to the anode, only half waves of current being conducted by the device illustrated. The rectified current may be used for any desired purpose; for instance, to charge the storage battery 19.

As the arcing tip 3 has a relatively greater mass than the filament, electrical erosion or disintegration will have but very little deleterious effect. The filament 8 is used only for a very short time when the device is started, hence the electrical disintegration of the filament is negligible. For these reasons the device will have a commercially long life.

In some cases, as shown in figure 2, the starting filament may be entirely dispensed with when the device is to be used only for relatively high voltages. In that case the arcing tip 3 is made sharp or pointed to such an extent that the arc will be certain to start from the point of the electrode as cathode when a relatively high voltage is applied to the terminals of the device; for example, by means of an auxiliary transformer winding 20. After the main cathode has been heated to incandescence, the switch 21 may be again opened and the switch 22 closed. Mr. Ferguson has found that by thus using a pointed electrode an arc may be started at a potential of about 60%, as great as the voltage required to start with a large surface as cathode. In other respects the device shown in figure 2 is the same as that already described in connection with figure 1.

A Ventilated Spark Discharge Gap

WHEN high frequency apparatus is employed in medical treatment, it is essential that spark discharge gaps be muffled for the patient's ease.

Former types of muffling proved unsatisfactory because of lack of ventilation, resulting in an irregular spark discharge and an output of gradually decreasing intensity. A discharge gap has been designed by H. G. Fischer which is substantially silent in operation and can be relied upon to maintain a predetermined operating characteristic.

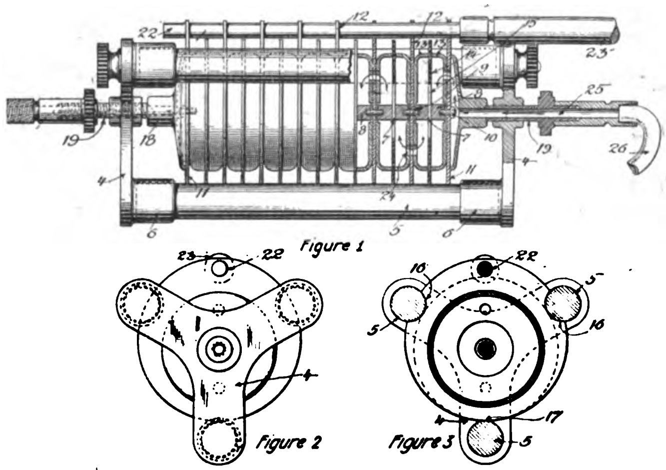


Figure 1—Showing side elevation of the Fischer spark gap with internal construction disclosed
Figure 2—End view. Figure 3—A transverse section

Figure 1 is a side elevation of the Fischer spark gap, parts being broken away to disclose the internal construction. Figure 2 is an end view of the same; and figure 3 is a section taken transversely.

In figures 1, 2 and 3, reference characters 4 represent what may be termed end holding plates which carry three side bars 5, preferably of glass, fitting in sockets 6 appropriately arranged in the end plates 4. The spark gaps indicated at 7 occur between units 8. These units are arranged in alignment and the adjacent ones of two adjacent gaps are connected together by screws 9, the end ones being connected by screws 10 with transverse plates 11 of current conducting material. A similar plate 12 is located upon each screw9 which connects the adjacent gap elements 8 of adjacent spark gaps. Each gap 7 is inclosed in a two-part housing 13, 13, each part 13 being fastened by screw 9 between the element and the adjacent plate 11 or 12. These housing parts 13 may also be of current conducting material. They are insulated from each other by a mica plate 14 forming a partition in the housing. Each plate 14 is, provided with a restricted opening 15 about the spark gap proper. The plates 11 and 12 are recessed at two points at 16 to be engaged by appropriate glass connectors 5, and are of dimensions causing them to engage the other glass connector 5 at 17 so that the glass connectors hold them in place.

An end clamp 18 presses against each end plate 11, holding the parts tightly together through a screw post 19 in threaded engagement with an end plate or member 4. All of the plates 11 and 12 are perforated at 21 for engagement by a connecting rod 22 having an insu-

lated handle 23, this handle permitting the rod to be pulled in and out to govern the number of spark gaps actually in operation, it being shown in figure 1 as having them all inoperative by reason of the passage of current through the rod 22 instead of across the gaps. So much of the multiple spark gap described has been tested and employed prior to this design, and it has been air confined in the housings formed by the housing parts 13, 13 that has in the past interfered with the prolonged efficient operation of the device. In accordance with Fischer's design, apertures or openings 24 are provided between succeeding housings and stagger these successive apertures with respect to each other. There is provided an opening 25 through the screw posts 19, which, in the present instance, constitute the binding posts to which connection can be made to the rest of the circuit. Air is admitted from the right, viewing figure 1, and passes along the path defined by the arrows and out at the left. In order that this action may be positive in operation, a tube 26 is provided for the introduction of compressed air continuously through the tubes. In the devices formerly in use the current has dropped within a period of, say, an hour and a half, from 700 milliamperes to approximately 200. When air has been forced through in the manner described, the efficiency has been unimpaired over a run of several hours, no variation in the current being shown.

Former Assistant Editor Wounded

ON the eve of the cessation of hostilities, word reached THE WIRELESS AGE that Captain Richard Douglas, formerly an editorial assistant, had been wounded in action. The injury is in his left foot, the heel being torn away and some doubt existing as to whether the foot can be saved.

Captain Douglas, 28 years old, secured leave of absence from editorial duties to attend the Massachusetts militia maneuvers, later entering Plattsburg with the outbreak of the war and receiving a commission as lieutenant. He was then sent to Camp Gordon and, in August, 1917, was promoted to captaincy and almost immediately embarked for overseas. Word has been received that he took part in the major engagements at Château-Thierry and St. Mihiel and was wounded during the week of October 21. As we go to press it is learned that he is in a base hospital at Baunedor.

Captain Richard Douglas, a former Wireless Age assistant editor, wounded in action

Conditions on the firing line were word-painted in characteristically broad strokes by the captain. In a recent letter he notes: "I haven't had my clothes off in ten days. I'm covered with fleas as big as grasshoppers; in more than a week the only sleep I've had has been in a sitting position in trenches filled with mud. It rains constantly. We've lived on bully beef, bread and coffee—and glad to get that—but we are going *forward!*"

A letter written a week before he was wounded depicts the bloody horrors of the war for democracy; how men were blown to pieces at his side, heads being severed from their trunks, and a battle fought in streams of blood. The war work auxiliaries come in for generous praise in this letter. Conditions which provided but two day nurses and one night nurse for some hundred-odd patients are spoken of, with the observation that these women and the head nurse "are splendid beyond praise, indefatigable, kind, gentle and cheery Ours just about fills my ideal of the holy woman of the Red Cross." This tribute to the Salvation Army is paid: "I've seen the Salvation Army girls serving rations and tending store with their masks on during a gas alarm. Coming out of the trenches, we often find them at hand with piping hot coffee and crullers."

Throughout, his letters have reflected that noble spirit of generosity which has made the American soldier so welcome and efficient abroad. As in his editorial work, Captain Douglas has recorded in military life the effectiveness of sincerity and earnest, upright effort, and THE WIRELESS AGE is proud to number him among those stalwart civilians who made material personal sacrifices to lead our troops to victory.

Book Reviews

Practical Aviation for Military Airmen. By Major J. Andrew White. Cloth binding. 6¼x9½ inches; 208 pages. Wireless Press. Price $1.75.

Although the literature on aviation is extensive it is not exhaustive. A particular place therefore awaits Major White's textbook, for in its pages is found the first complete presentation of the varied knowledge required by the military aviator.

In fifteen chapters he has covered the subject in its entirety. The reader is first made acquainted with the theory and principles of flight and types of airplanes; this knowledge is then applied to consideration of the elements of airplane design, followed by a chapter which discusses how stability in flight is gained and how the machine is controlled. The necessary knowledge of materials, stresses and strains is then given, so the aviator may realize the importance of thoroughly assimilating the succeeding chapter which explains in detail how airplanes are erected and assembled, how controls are rigged and wires tensioned, and stabilizers and wing surfaces aligned.

Unlike most aviation books, this volume does not ignore the important subject of engines or refer the reader elsewhere for enlightenment; four chapters are given to aeronautical motors, beginning with fundamentals of motive power and continuing through study of pistons, valves and carburetors, ignition, cooling and lubrication, to types of motors, and the operation and care of engines. The subject is so clearly presented that an absolute novice may acquire within a few hours a fair knowledge of the functioning of each part of a high-powered aero engine.

Instruments and equipment for flight is the next chapter's subject, profusely illustrated with the various devices and descriptions of their use and operation. Then the practical aspects of flight are discussed, beginning with the exact manipulation of controls for simple take-offs and landings, straightaway flights and turns. Cross-country flight and air navigation by instruments is then explained in detail and the problems of night flying carefully reviewed. Air acrobacy, upon which all fighting depends, is made clear by diagrams of the evolutions and full explanation of how the controls are manipulated to produce these amazing dips and dives, loops and turns. Meteorology has a separate chapter, this vital subject being considered in the practical applications of the science to flight conditions. Treacherous wind eddies and currents and the unfavorable conditions which are revealed by cloud formations are made known to prospective aviators and the effect of obstructions on air currents graphically described.

The two final chapters have no parallel in the literature on aviation. One discusses aerial gunnery and combat, bombs and bombing; the other deals with reconnaissance and fire spotting for artillery. Not only has the author in both cases pictured and described the armament and devices, but he has exhaustively gone into aerial tactics, anti-aircraft fire, bombing air raids, estimating enemy strength, code telegraphing, airplane radio apparatus and reconnaissance photography. The highest commendation is due for this portion of the volume, for the material here has evidently been laboriously compiled by searching investigation into actual warfare occurrences, analysis of principles and conditions affecting success in military airmanship being thereafter defined for the first time.

The volume concludes with an appendix containing conversion tables and mensuration rules, together with a nomenclature of aeronautical terms and their French equivalents, the phonetic pronunciation of the latter being given to facilitate intercourse with Allied aviators.

On the whole, the designation "Practical" in the book's title is entirely justified. The illustrations—200 or more—have been prepared with care and tell a story in themselves. The supporting text, however, will perhaps excite the principal comment. Major White has departed from usual textbook arrangement and has so prepared his material that the descriptive matter in every case is directly under or facing the illustration with which it deals. In no instance is the reader required to turn the page. This feature's value is further emphasized by the use of relative sizes and boldness of type to value the importance of each statement as it is made.

While the book is less a treatise on aeronautical engineering than a fully practical text for men who expect to fly and want to learn in the shortest possible time, the mass of data contained in the volume will insure it a place on the bookshelves of even those whose interest in aviation is purely on the theoretical side. Certain it is that this latest contribution to the literature of the aeronautic field will receive a hearty welcome wherever it goes.

Obtainable through the Book Dept., The Wireless Age.

A Dictionary of Military Terms. (Revised Edition.) By Edwin S. Farrow. Cloth binding. 5x7 inches; 682 pages. Crowell. Price $2.50 net.

Nothing is more disconcerting to the newly commissioned officer than to hear military terms in common usage which army manuals do not mention. Many an uncomfortable moment will be spared those to whom Tactical Instructor Farrow's dictionary is available for ready reference. While the compiler's primary purpose seems to have been to include the many specialized terms used in modern warfare, the work has been made sufficiently exhaustive to stand by itself as a ready reference for determining the exact meaning of both ancient and modern works on military subjects.

The value of a work of this character is perhaps best instanced by quoting a few examples from its nomenclature, words which are familiar to experienced officers but are seldom comprehended by the novice. For instance: buzzacot, dixie, revetment, logistics, indirect laying, full sap, terrain, enfilade, bracketing, chevaux-de-frise, are terms which may be heard any day about a cantonment but are likely to be meaningless to the officer from civilian life. Another glance through the volume discloses these, of which the same may be said: deflection, whippet, martinet, line of investment, kitchen police, parados, elan, allowance of quarters, aparejo, camion, barbette, ballistics, double sap, striker, ricochet, oriented—and so on. There are 12,000 definitions in the volume, a fairly large percentage of which will appear entirely new to the officers' camp graduate, yet are in daily use by officers of the regular army.

January, 1919

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Volume 6 Number 4

Protests With a Point—
Varied Views on Government Ownership of Wireless

The Wireless Age

Edited by J. ANDREW WHITE
E. E. BUCHER, Technical Editor

Vol. 6 — Contents for January, 1919 — No. 4

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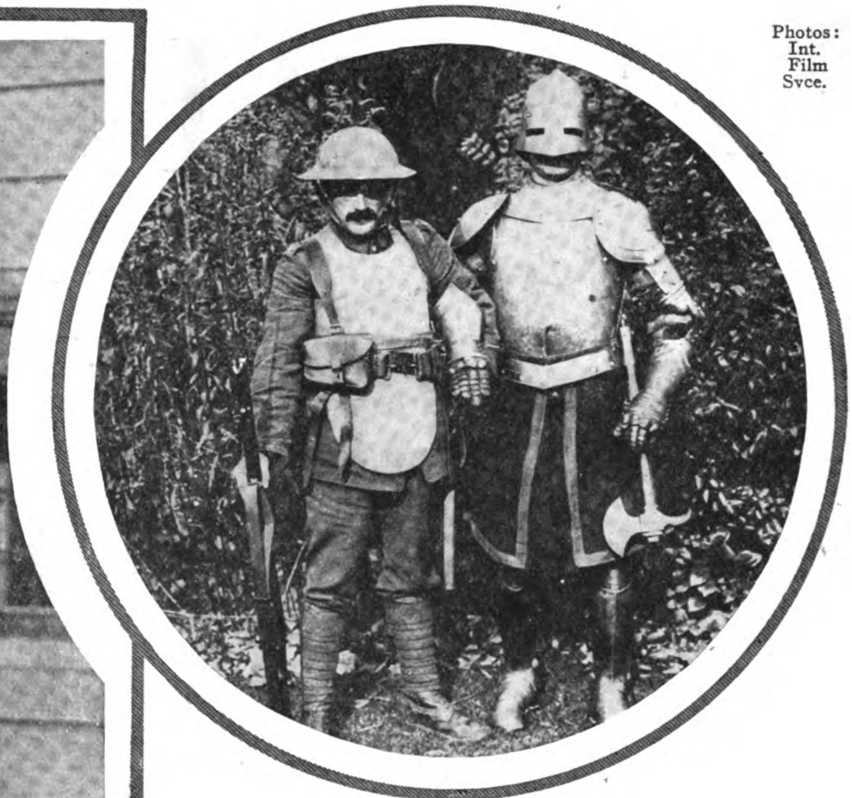

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Modern Military Armor

Above, in circle, a modern fighting man's dress contrasted with ancient body armor, showing that protective metal covering has not lost its usefulness. The modern doughboy here shown has dispensed with cumbersome steel but is well protected against bayonet and shrapnel

To the left is illustrated the helmet which is capable of stopping a rifle bullet and body armor made of semi-flexible thin spring steel plates sewn together in a canvas sack

A favorite pastime in Flanders, now that the guns are silent, is trying on suits of German armor left behind by the Boche in his flight

Vol. 6. No. 4. January, 1919

THE WIRELESS AGE

WORLD WIDE WIRELESS

Weagant's Solution of Static Problem Arouses Controversy

IMMEDIATELY following the announcement that the static problem had been solved by an invention of Roy A. Weagant, reported in the December issue, Newcomb Carlton, president of the Western Union ridiculed the idea, stating that such delusions had been coming up ever since Wireless was discovered.

Mr. E. J. Nally, Vice President and General Manager, Marconi Wireless Telegraph Company of America, being asked for further comment upon President Carlton's statement, said that while he deplored public controversy it was being forced upon him by the animus of the Western Union, adding "science and progress have ever met with the disdain of those who like to follow the lines of least resistance. These non-progressives may be divided into classes. There is the man who says it can't be done, the man who fears it might be done and the man who would like to say it shall not be done. Mr. Carlton is entitled to the distinction of adding another class for himself, in that he, claiming cryptic knowledge of something he has not seen and could not know anything about, empirically condemns it.

"It is not a nice position for the head of a large corporation to take, but he is following historically in the footsteps of some other Western Union presidents, one of whom deflected the genius of Elisha Gray from developing the telephone. Another president of similar 'low visibility' completely failed to encourage the genius of Edison, who was forced to work elsewhere than in the telegraph business, and whose wonderful achievements since are known to all mankind.

"But all of this perhaps accounts for the lack of progress of the science in land line telegraphy, which has advanced very little beyond the days of Morse, and certainly not at all beyond the days of Edison's connection with it. Mr. Carlton's statement that the claim for continuous transatlantic communication through the operation of the Weagant invention is 'humbug' is utterly false. For this is the very thing that has been established beyond a peradventure."

Michael I. Pupin, professor of electro-mechanics at Columbia University, also issued an opposition statement:

"The removal of static interference," said Professor Pupin, "is the great problem of wireless. It may never be discovered. An invention of such tremendous importance should not be announced until it has been tested by disinterested experts.

"There are already a dozen inventions that will remove static under certain conditions. What we want is an invention that will remove static under all conditions. We want to be able to send wireless messages in spite of everything excepting lightning and the will of God."

Professor Pupin, who is inventor of the Pupin coil, explained that he had demonstrated his own inventions before a group of scientists before he made them public.

Complete tests of the invention of Roy A. Weagant, which, it is asserted, eliminated static interference in wireless telegraphy, will be made next Summer, Mr. Weagant immediately announced.

"We are going to make the tests that Professor Pupin calls for during next June, July, and August," Mr. Weagant said. "They cannot be made immediately because nobody would accept tests made in Winter, when there is much less static electricity to contend with than in Summer. I cannot say yet where the tests will be made, but they will be carried out in the presence of disinterested scientists. In all probability Professor Pupin himself will be invited to attend."

"The skepticism was quite natural," he said. "It sounds big to make the announcement that we have perfected wireless after all these years, but I know we are safe. I would like to tell the whole story, but I am restrained until the peace pact is signed. I don't expect people, including scientific men, to believe it until they use it. It is like flying—people would not believe it could be done until they actually saw it done."

President Constantly in Touch with Land on Overseas Trip

SPECIAL arrangements never before used were made for handling President Wilson's wireless messages and to keep him in constant touch with Washington.

This announcement was made by Secretary of the Navy Daniels in connection with a statement that the Navy Department had been in continuous communication with the George Washington and the flagship Pennsylvania since they sailed from New York. He said:

The George Washington and the battleship Pennsylvania are both equipped with the most modern radio apparatus, some of which was installed for this particular trip.

This apparatus includes, on the Pennsylvania, the most powerful transmitting set on any United States naval ship and also special receiving apparatus for receiving from high power stations used ordinarily only for transatlantic messages. The George Washington was also especially equipped with similar receiving apparatus. On board both ships were installed radio telephones and the newest type of low power radio sets for use only in communicating from ship to ship.

All messages for the President were sent by the new naval high power station at Annapolis, which is five times as powerful as the Arlington station. These messages were received by the George Washington

and the Pennsylvania simultaneously. All replies were forwarded from the George Washington to the Pennsylvania and relayed to shore by the Pennsylvania.

At three special naval radio receiving stations, one in Maine, one in New Jersey and one in the Navy Building, Washington, expert operators listened continuously for the Pennsylvania's messages. The messages when received were forwarded with utmost despatch to the transatlantic radio division of the office of the Director of Naval Communications in the Navy Department, and the three copies compared to insure accuracy. All outgoing messages passed through the same office in Washington.

As the Presidential party approached Europe, by arrangement of the Navy Department, special receiving stations in both England and France listened for messages from the Pennsylvania, and one of the French high power stations forwarded messages direct to the ship. The President was thus kept in touch with Washington and Paris or London simultaneously.

Interior of the wireless room on the S. S. George Washington—By means of this apparatus the President was kept informed of the world's doings during his trip to France

N. Y. State Troopers Get Wireless

MEMBERS of the State Constabulary operating in New York City's suburbs, it was announced on November 23, are to be equipped with wireless telegraphy as a means of communication.

The Naval Intelligence Department informed Lieut. John Walton of the troopers that the powerful apparatus with a 5,000-mile radius, which Corporal Daniel Faber of Highland Falls station recently seized from Glen Vanvalkenberg at his home in Westkill and confiscated, is to be presented to the troopers. This is in recognition of the services they have rendered the Navy Department in finding and confiscating many wireless stations during the war. Lieut. Walton will have the apparatus transferred to White Plains and set up there so the police can send and receive messages.

Report That Ex-Kaiser Has Station

WILHELM is reported to be closely in touch with Germany from his Holland domicile. One dispatch from Amsterdam today reported that a wireless station has been installed at the Van Bentinck castle and that German airmen flying over Maarn drop messages for him.

Marconi to Sell and Lease Ship Equipment

EDWARD J. NALLY, Vice President and General Manager, Marconi Wireless Telegraph Company of America, on his return from Washington, where he went for conference with the Navy Department, has made known a change in the policy of the Marconi Company under which it will in future sell as well as lease wireless apparatus. The first result of this change in policy has been the sale to the Government of the apparatus on some three hundred ships now under Government control and all of the small coast stations which the Marconi Company has maintained in the past but which it no longer needs under its new policy.

Mr. Nally stated that the terms of the sale were based upon the earning value of the stations and the apparatus, and added that the Secretary of the Navy had dealt with this question with the utmost fairness and with just consideration of the rights of the company's stockholders.

This transfer does not in any way affect the status of the company's large stations for transoceanic communication, but it is believed that it will have met every need of the Government for the control of domestic wireless and that there will now be no occasion for the Government seeking to secure control or ownership of the large high power stations which were built with the principal object of rendering to the public international transoceanic wireless service in competition with the cables, which is by far the most important part of the Marconi Company's activities.

Progress Announced for Japan's Radiophone

AN exchange to connect wireless and wire telephones is to be established in Kobe, Japan, before the first of the year by the Government Department of Communications, it is reported. A wireless tower 180 feet high is now being erected in front of the largest of the Kobe telephone exchanges. Wireless telephone messages from vessels within 100 miles of the South Japan port will be connected by central operators with the telephones of subscribers in Kobe, Osake, Kyoto and neighboring cities, thus serving the most densely populated section in Japan.

Police Radio Saves Lives and Dollars

ACTING police commissioner, of New York, received on December 5 a report on the work done by the wireless telegraph branch of the police department during the past two years. The wireless tower is on the roof of the police headquarters building, and the seagoing end of the service is aboard the police boat, Patrol, which covers the harbor.

The report shows that merchandise valued at upwards of $400,000 and some twenty-five lives have been saved mainly through information received by wireless. About 2,000 messages have been handled by the service. Headquarters has been able to receive messages from a distance of 1,500 miles, and to transmit them 300. On the Patrol are two operators, John Ward and Russell McKee, both patrolmen, and stationed at headquarters are Charles Goul, John E. Hanley, and William J. Ferrick, also patrolmen.

Marconi Company Opposed to Government Ownership

THAT the Marconi Wireless Telegraphy Company of America is unalterably opposed to Government ownership and operation of the radio stations in the United States which it owns, and which have been under Government control and operation since before this country entered the war, was indicated by a statement issued by Edward J. Nally, Vice-President and General Manager of the company. The statement follows:

The Marconi Wireless Telegraph Company of America, through its Vice-President and General Manager, Edward J. Nally, makes further answer today to the questions raised by the bill which has been introduced by Representative Alexander, Chairman of the Merchant Marine Committee, which seeks to give permanent government ownership of all radio communication through the acquisition and operation by the Navy Department of all wireless stations in the United States used for commercial purposes.

"Mr. Nally wished to particularly point out that the situation with respect to wireless was in no way different from that of communication by telegraph, telephone, and submarine cables. In other words, there is no special reason for Government ownership and operation of radio communication that does not equally apply to other means of communication.

"The fact that the statement prepared by the Navy Department and given out by Judge (Representative) Alexander states that transoceanic radio telegraphy is not a serious competitor of the cables, and that high-power stations are not yet able to receive from one another all day and in all seasons, proves that the Government is not able to make the most of its opportunities and get the best results from transoceanic wireless operation. This statement is a weak attempt to minimize, in the eyes of the public, the importance of wireless competition with the cables.

"As a matter of fact, before the war, the Marconi Wireless Telegraph Company had inaugurated its transpacific service with Japan and was building up a very successful commercial business with the Orient. The cable companies recognized that there was a competitor in the field, because they were forced to reduce their rates and to add new classes of service, which, during all the years they monopolized transpacific communication, they had refused to do.

"The Marconi Company, by reason of its organization and its improved apparatus, particularly with the aid of the Weagant invention, of which wide announcement was recently made, is in position to guarantee to the business public accurate and reliable service at all times and at rates lower than those charged by the cables. Already it is being petitioned by business firms on the Pacific Coast and in New York to resume its service, owing to the congested condition of the cables and the poor service which they are giving.

"It seems a pity, at this time, when transoceanic communication is so important, that commercial wireless companies should not be given the fullest opportunity to meet the public demands."

By way of answer to that part of the statement made public by Representative Alexander as Chairman of the House Merchant Marine Committee, that, except in very special circumstances, wireless telegraph companies have never made any profit, except by the sale of stock, the Marconi Company pointed to the financial showing it made for the years 1914 to 1917, inclusive. The figures, taken from the annual report for the year ended December 31, 1917, show:

Net income for year 1914, after charging reserves, carried to balance sheet, $149,877.47; for 1915, $177,316.51; for 1916, $259,888.80, and for 1917, $617,772.69.

The company has issued and outstanding $10,000,000 of common stock. Since its organization, in 1899, it has paid two dividends, one of 2 per cent. in 1914, and one of 5 per cent. in 1917.

Wireless Beats the Dutch

SOMETIME during the war British naval officers were searching the mail bags of a Dutch liner bound for New York and extracted therefrom about $200,000 in American railroad bonds. In spite of the angry arguments of the purser that the bonds belonged to the Dutch bankers whose names appeared on the envelopes the North Sea skippers took them aboard the cruiser and from thence they found a resting place in the British treasury.

Not long afterwards a delegation of lawyers representing the Dutch and American interests visited the British Embassy and laid the case before a representative of Great Britain.

He listened politely and said: "Gentlemen, you apparently have a good case, but wait a moment." With this he asked the clerk to bring in file No.—.

Taking a few slips of paper from the file he read

Morris for George Matthew Adams Service

Another war decoration

to the lawyers not only the names of the German bankers who had sold the bonds through Dutch banks but the names of the American bankers who were actually to receive said bonds, and also all the wireless messages in regard to the transaction which had been carefully decoded by the British Admiralty experts.

The astonished lawyers politely withdrew.

Sayville Bought by U. S. Is Report

IT was semi-officially announced here on November 26 that the Government had bought the Sayville Wireless Station outright after it was taken over.

The station was owned by a so-called "American syndicate," and the question had arisen whether it will revert to its original private owners.

Boys Congratulated on Rounding Up Spy Stations

A TELEGRAM from Secretary of the Navy Daniels was received by the Boy Scouts of America November 15. It characterized them as "chivalric young crusaders" because of their work during the war. It also disclosed that the Scouts, working on behalf of the Government, had discovered hundreds of illegal wireless plants.

Twenty-six of these plants were found in one day. A German alien operating an underground raido station with a small New England river supplying the motive power, was taken into custody and interned. This plant was said to have been exchanging German Government messages between America and Berlin. Details of these scout activities are expected to be made public later.

Fair Californian Didn't Land Navy Job

THE latest and bravest storming of masculine citadels comes with the entrance of women into the hitherto taboo field of wireless telegraphy. The horrors of higher mathematics have been braved, the difficulties of taking twenty words a minute in the wireless code conquered, by Miss Reavis Hughes, daughter of Mrs. Walter J. Hughes, who in October completed a regular operator's course at the Polytechnic High School, Los Angeles.

But women telegraph operators are still somewhat of a novelty to United States Government officials, as Miss Hughes to her sorrow found out. After taking her regular man-sized course, passing a strenuous all-day examination with all kinds of intricate code tests and other lively matter, she emerged with flying colors and word was sent on to Washington, D. C., that Reavis Hughes was a first-grade operator. A license was sent to her, followed by a telegram notifying her of her appointment to take a special radio course for special work under the War Department, an offer which was as promptly withdrawn when it was made plain that "Reavis" was a woman and not a man. Consequently, Reavis Hughes, first-grade operator, still awaits a job, but feels certain that one soon will be forthcoming.

Britain's King Broadcasts Peace Congratulations

THE White Star liner Megantic, which arrived November 18 from Liverpool, was the first passenger vessel to be signaled from Sandy Hook since the United States entered the war. The Megantic had been used for transporting American troops overseas and will now be used for bringing back the troops to Canada.

When the news of the signing of the armistice was received by wireless late at night Captain F. E. Beadnell ordered all the decklights to be turned on for the first time since early in 1915, when the German submarines became active. All on board were roused at 7 o'clock the following morning by the continuous blowing of the siren and at 8 o'clock the flag was hoisted at the stern, while the band played "God Save the King." At noon Captain Beadnell mustered the crew and the passengers on the forward deck and read a message received by wireless from King George to the captains of all ships flying the Union Jack congratulating them for the part they had taking in assisting to win the war.

Warning Issued About Amateur Licenses

S. W. EDWARDS, United States radio inspector, with offices in the Federal building, Detroit, issues instructions to amateur wireless operators on the procedure to be followed in obtaining permission to use their equipment, warning them, also, that severe penalties may be imposed on any who attempt to use stations without proper authorization. Inspector Edwards says:

"They are advised that applications for station license may be made at once and that all such applications will be filed in the order received.

"The opening of any amateur wireless station and the beginning of amateur activities is forbidden under penalty of arrest and confiscation of all apparatus. They are informed that as soon as the ban has been lifted and all restrictions on this class of station removed, all those who make application now to this office will be individually notified by the proper government authorities. Until such a time, however, they must not use wireless apparatus in any manner or for any purpose, testing included. Should those who make application for license fail to receive any notification within a week after the treaty of peace is signed they may request further information from this office.

"After all restrictions on amateur activities have been raised and if it is the amateur's intention to use any transmitting apparatus whatever regardless of its range, they will be required to secure both an amateur station license and an operator's license for which no fee is charged. In view of the fact that such licenses held and call letters assigned before the outbreak of the war are regarded as canceled, they cannot be renewed and therefore new ones must be secured. Use of transmitting apparatus without such licenses is punishable by a fine of $500 and forfeiture of all apparatus."

Wireless Aid in Breaking Hun Morale

WIRELESS telegraphy, its conquests and achievements during the war, will be one of the alluring chapters soon to be unfolded before the public, now that the veil of secrecy imposed by the universal censorship is being removed. It will be a record of performances that will be equalled, or rather exceeded, only by the plans of development that are in prospect for the world-wide political and commercial expansion of the immediate future.

Since the outbreak of the war, and more particularly since the United States entered it, the wireless has developed a universality of uses that outrun the imagination.

Everything of international interest the President said during the war was distributed through the air. The main purpose of this distribution was to reach the people of the Central Powers, that is to say, Germany, Austria-Hungary, Turkey and Bulgaria. These methods were employed to get the viewpoint of the United States before the people of the Central Powers. First, whatever was to be sent, whether it was something spoken or written by the President, or whether it was a statement as to the number of troops that had been sent to France, was sent by wireless across the Atlantic and put into the air over all Europe.

It is assumed that the German wireless stations picked all this news out of the air and while the officials in charge of those stations did not give it newspaper publicity it did gain much publicity by being passed from mouth to mouth.

How Science Beat the Hun

The Accomplishments of the Trained Man of Science in the War *

By J. S. Ames
Professor, Johns Hopkins University

(*Continued from the December,* 1918, WIRELESS AGE)

BOTH the army and the navy need airplanes for their operations; but after their demands are supplied, there remains the wide expanse of the air through which attacks can be made upon the enemy, far away from the battle-front and the coast. Great Britain has recognized this all-important fact, and has been building a great fleet of airplanes for this new service. In this, new instruments, new types of machines, new guns and bombs are required.

There are two main problems in connection with the submarine, first to locate it, second to destroy it. Methods of destruction are at hand in the shape of depth bombs; but methods of detection so far have not been eminently successful.

From an airplane one can see through water only to a limited depth, never more than twenty feet, and so the main reason why the seaplanes have been so successful in destroying submarines is not due to the fact that the observer in the airplane discovers his prey, but is that his machine has such great speed, three times that of a destroyer, that when news is flashed that a vessel is being attacked by a submarine it can often reach the spot in time to drop its bomb effectively. The detection of the presence of a submarine is a definite physical problem; and it is not an exaggeration to say that at least one-fourth of the physicists of note in England, France and this country have been engaged in the attempt to solve it.

What lines of attack upon it are open? Not many.

The submarine in motion emits certain sounds; can they be heard? It is a solid body; can one obtain an echo from it? It is made of iron; can this fact help through some magnetic action?

These are the obvious lines of approach, but one should not hastily conclude that there are not others.

Without stating, and I may not, how far successful these efforts of the physicists have been, I may note that the method which is now being tested by our Navy is one elaborated by a distinguished professor of mathematical physics.

In the course of these extremely numerous experiments upon the submarine question several beautiful methods have been developed which in the future will have great scientific importance; one of these, due to a French physicist, is one of the most interesting developments in physics made within a decade.

Another submarine problem, which is by no means of secondary importance, is to develop a method by which one submarine may communicate with another or with the shore. I do not think I am saying too much when I state that this has been solved, even for considerable distances.

I cannot leave the subject of the airplane and the observation balloon without referring to the question of maps and map-making, in connection with which the former are so important.

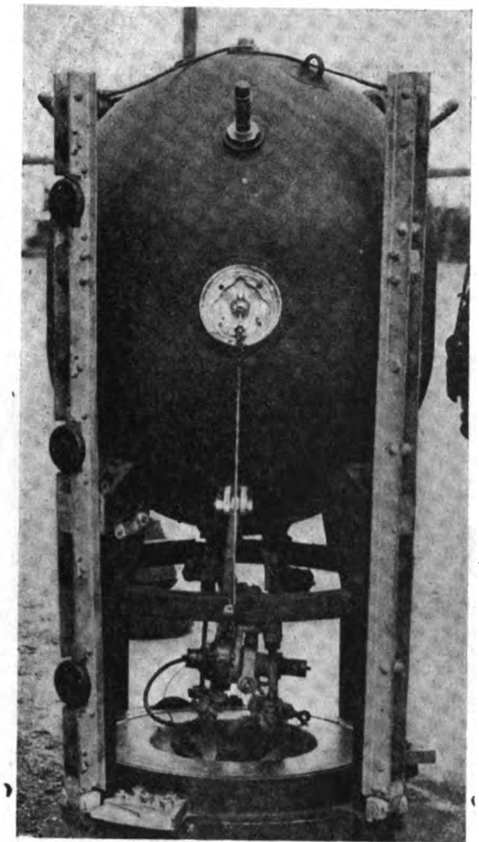
Until one has been at the headquarters of an army, it is not possible to realize the extent to which maps are used, or the various types of maps required. There are maps showing roads, paths and trenches; maps for staff officers, for regimental commanders, for company cap-

Maj. Gen. George O. Squier, Chief Signal Officer, U. S. A.

tains, for sergeants; there are maps showing the position of the enemy's ammunition dumps, aerodromes, signal stations, anti-aircraft guns; there are maps showing the location of the enemy's batteries; there are special maps for the use of the quartermaster, etc., showing where each horse trough, each well, each storehouse is. Map-making has long been a function of engineers; and the most marked improvements have been in the main mechanical, first in introducing quickly on a map the revelations made by aerial photographs, second in increasing the speed of production of a map. In many cases, entirely new sets of maps are made each day, each one containing the information obtained within the preceding twelve hours.

* Abstract of an Address at the University of Virginia.

Another department of science closely connected with airplanes and balloons is meteorology. We associate this word with weather prediction and with uninteresting data; but it must be remembered that these data include



Press Illustrating Service
Mine taken from a captured U-boat now a souvenir on exhibition in England

observations of temperature, of moisture content of the air, of air pressure, of wind direction and velocity at different heights above the earth. A knowledge of all of these is absolutely essential for each day's battle.

Artillery at a long range is useless unless the temperature, the moisture content and the wind are known accurately. Gas attacks are controlled by the knowledge of winds and barometric pressure. The safe strata for airplanes must be known; and for long distance work weather prediction of every description is essential.

So important is the subject that observation stations with competent forecasters and scientific observers dot the battle-front at close intervals; and the home offices send almost hourly reports to the fleets and the coast-stations.

What strikes a layman most forcibly when inspecting a meteorological station near the battle-line is the rapidity of operation. Only minutes lapse between the observations and the deduction of the conclusion. One realizes then how much meteorology has grown into an exact science.

Modern artillery is a good illustration of the application of pure science. All of us are now familiar with the method by which artillery fire is controlled by the aid of airplanes; but you may not realize its wonderful accuracy.

If the enemy's battery is located, by any means, this implies that its position on a topographic map is known to within, say fifty feet, often less. It may be at a distance of ten, fifteen or more miles. Then to hit it, an exact knowledge of the properties of the powder used and of ballistics is required. With this, the target is reached in an astonishingly short time.

I have witnessed myself the destruction of a German battery at a distance of eleven miles by a French battery of three thirteen-inch guns, all done within ten minutes, the exact aim being secured after three salvoes.

The perfection of the mechanism of the French 75 and 37 millimeter guns is known to us all; but we hear much less of the English and American guns. I can assure you that this is only a curious bit of camouflage.

Of all the numerous ways in which physics has been called in to assist artillery, I know none so interesting as is illustrated by anti-aircraft gunnery. The problem is most difficult. An airplane may be traveling at a speed of 100 or 10 miles an hour, it rarely keeps a constant course, it may be at a height above the earth of 20,000 feet, nearly four miles. The man aiming the gun must know the position of the airplane and its speed, and then must make his calculations so that when his shell reaches the immense height, it shall be so timed as to meet the airplane.

It is true that it is rather a question of the airplane meeting some fragment of the shell, than the converse; but the problem is the same. When it is realized that numerous hits are recorded at heights of 20,000 feet, and when one hears the personal experiences of the pilots, it is clear that the problem has been solved fairly well. A former student of mine writing to me a few days ago, after telling how he had "speared his first Hun" on his first day at the front, added that the German shells rarely missed him by more than ten feet, and he was flying a rapid scout machine and was manouvering for position all the time.

I am familiar with the French and British methods of aiming their guns; and, as you can yourself decide from reading the newspapers, they are not inferior to the ones used by the Germans.

One can not speak of artillery without thinking of gas shells and gas attacks. The Germans were the first to use this hideous means of warfare, although it is well known that it was proposed to the British war office many years ago and the decision was reached that it should not be adopted.

When poisonous gases first became a weapon, it was in the form of gas clouds, rolled along the ground by the wind, the gas having been released from cylinders in the front line of trenches. For perfectly obvious reasons this mode of gas attack was soon replaced by the use of large shells filled with the liquefied gas. When the shell was exploded by a contact- or a time-fuse, the gas would escape and work its action in all the neighborhood.

There are two problems associated with this mode of warfare: an offensive and a defensive one. The former is to make a gas which can be liquefied, is not so light as to diffuse upward too rapidly, and which will either kill the man who breathes it or will in some way incapacitate him; the latter is to make a mask or a suit of clothing, if necessary, which will enable the wearer to breath and do his work in the contaminated atmosphere.

We hear most of course about the terrors of the gases used by the Germans; but, if they would only describe

to us their feelings about the gases sent them, our point of view would change. Some might even have a feeling of pity.

Both the questions, of defense and offense, are strictly scientific ones, in the main belonging to chemistry. The researches undertaken in Great Britain, France and this country are so numerous that the truth is almost unbelievable. It is safe to say that there are at least 2,000 chemists in America alone working on problems connected with the military use of gas.

We can well be proud of the achievements of our chemists. Among many things which I may say I shall select two: they have devised a mask for use inside a gun turret on our large ships where a particularly dangerous gas is liberated during a battle, and the masks supplied our soldiers are at least 20 per cent. better than either the British or French mask, and they are better than the German model.

As another illustration of the usefulness of chemists in this war, one should state what has been done by them to render the allied countries and our own independent of Germany from an economic standpoint. All I shall do, however, will be to mention two subjects: dye-stuffs and drugs; and you know the rest. It should be remembered, though, that this is not the full story, only an interesting chapter.

One of the most important military questions, which in the end is a purely physical one, is that of signals. Our army is most fortunate in having as its Chief Signal Officer a man who is a doctor of philosophy in physics, from Johns Hopkins University, Major General George O. Squier. He certainly knows his subject from the scientific standpoint as few military officers can know it.

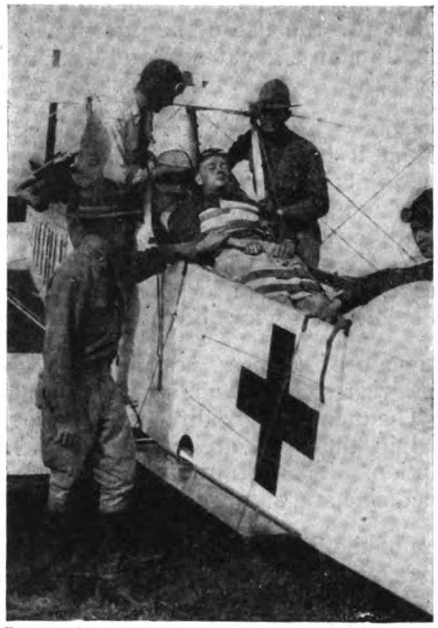
Think for a moment of the variety of signals required. Those to and from airplanes and submarines have been referred to. In addition, each trench, each outpost, each reserve force, each artillery battery must be in unbroken communication with the brigade headquarters, and the division and staff officers. Wireless telegraphy and telephone are used in various ways; ordinary telephones are installed everywhere; carrier pigeons must be bred and trained; signals using both sound and light are most useful. It is not merely a matter of perfecting signals which work satisfactorily; much more is required, safeguards must be devised which make it impossible for the enemy to observe or read them. When I say that all this has been done, and done to a large degree by our American physicists, I am telling only the bare truth. I wish it were permitted to tell more.

Signals as used by the Navy are not as varied as those required by the Army. But there is one special problem which concerns the American Navy more than any other. In sending ships and transports to Europe in large groups, at night no lights are shown by any vessel; the question then arises, how is it possible to maintain relative distances and positions? This sounds as if it were an almost hopeless proposition; but it is not; and I have seen a solution which seems satisfactory, again the ingenious idea of an American physicist.

The demands upon photography are great, largely in connection with airplanes; and the methods elaborated by the British and French scientists are beautiful. There are other phases, though, of almost equal importance. Can we not take photographs of objects which the eye can not see, owing to clouds, haze or distance? This matter is solved in a large degree as a result of our spectroscopic knowledge.

By photographic methods it is possible to discover the location of the enemy's batteries unless they are hidden with the utmost care.

In this last case resort is had, as you know, to what is called sound-ranging. When a gun ejects its shell in the direction of the enemy, the latter hears in succession three sounds; first that due to the passing of the shell through the air, in general a hissing sound; then the proper sound from the gun mouth, a boom; and finally the sound of the explosion of the shell. Sound waves travel through the air with a comparatively slow velocity, slightly over 1,000 feet per second, and so if observing stations are placed at different distances from the gun, any one type of the three sounds, *e. g.*, the boom, will be heard at different instants of time. It is easily seen, then, that methods may be devised by means of a system of triangulation, by which the location of the gun may be determined. The accuracy of the methods in use is so great that now within a few minutes after the firing of a gun its position is known definitely to within limits less than the accuracy of the guns which are responsible for the destruction of the enemy's battery. This last limitation is due to an unavoidable variation in shells and their powder charges, and to variations in the atmosphere.



International Film Service

First aerial ambulance in air service of U. S. Army—Photo shows the ambulance attendants lifting a wounded soldier upon a stretcher into the berth of an airplane

This method of sound-ranging is simple in theory, but extremely difficult in practise, owing to vagaries of the wind and to the confusion caused by simultaneous discharges of guns. The former difficulty has been overcome by a brilliant British physicist; but, as you have probably seen in the papers, one of the ways used by the Germans to conceal the position of its big guns by which they were bombarding Paris was to discharge a dozen other guns simultaneously.

A somewhat similar problem arises in connection with determining the position of an airplane at night, or in cloudy weather. One inherent difficulty here lies in the great speed and great height of the airplane. Rumors have reached us that the British have found a method; but, whether this is true or not, the problem is not hope-

less. The airplane in flight emits sounds, loud ones; with that fact as a basis, its detection is therefore certain.

I am not sure that any of you would of your own account think of astronomy as being a practical science; yet there has been found a definite usefulness for the disturbances on the sun, known as sunspots; and astronomers easily turn from calculations of the motions of comets, planets and satellites to those of twelve-inch shells and bombs dropped from airplanes. The instruments used by navigators on the sea and in the air when the flights are long are essentially those invented and adopted by astronomers. In fact an American astronomer has perfected within the past few months an entirely new instrument for the use of navigators, an instrument which will mean a great deal to both our sea and our air force.

Another science which seems remote from war is geology, and yet it has proved not simply useful, but essential. The minute you realize that war is concerned with trenches, dugouts, military mines, tunnels, water-supply, etc., you see that here the geologist must be summoned to help. He alone knows from his maps, made in times of peace, how to plan for any emergency requiring one to go below the surface of the earth.

There is a group of sciences, not physical, which has, in the end, the greatest responsibility in bringing victory to our arms. The men who are directing the work, in the laboratory and in the field, are university men almost without exception. This group includes experimental psychology, medicine and surgery and hygiene.

The function of the first of these is to devise such tests that we may be reasonably sure that a man selected for a certain duty can perform it. As a simple illustration, think of an airplane pilot. It is not difficult to analyze his responsibilities and to state the qualities which he should possess; further it is not impossible to devise experimental tests which may be performed on the ground in order to see if he has these qualities or, if not, to see whether he can acquire them in a short time. Our aviation section of the army has equipped laboratories along these lines, and the results obtained are most interesting. Certain generalizations will undoubtedly be deduced, and the examination of candidates can proceed more rapidly.

As soon as our military departments can be persuaded to recognize the fact that experimental psychology can in many, if not all, cases state definitely that a man with such and such reactions ought not to command a company, a regiment or a ship, our fighting forces will become efficient, not before.

The varied activities of our medical departments are known. When I think of them, what is uppermost in my mind is their progress in combating disease. I may be pardoned for speaking of two illustrations.

The gas-bacillus, the cause of hospital gangrene, has lost its terrors absolutely; first by the Carrel-Dakin treatment of wounds, second by Dr. Bull's discovery of a serum which may be used exactly as diphtheria antitoxin is used. Dr. Carrel is a Frenchman and Dr. Dakin is an Englishman; but both have lived long in this country; and Dr. Bull perfected his method at the Rockefeller Institute, New York.

My second illustration is the discovery of the means by which trench fever is conveyed from patient to patient. This is not a dangerous disease, but is one which renders soldiers non-combatants for the time being. This discovery has just been made in France by two of our American doctors, both attached in normal times to American universities.

You are probably saying to yourselves, "Yes, this is interesting to hear about the scientific achievements of ourselves and the Allies; but what is the real use of it, when Germany, which leads the world in all branches of science, is our enemy?" No educated man should assert that Germany is the leader of the world of science. It is true that Germany modestly acknowledges it, and every American newspaper supports the claim in ways both direct and insidious. The facts, however, do not support it. Many years ago it undoubtedly was true, but a full generation has passed since then.

The Prussian form of government does not encourage individuality or freedom of thought; and these are essential for scientific discoveries and scientific development. In all seriousness I maintain that Germany has not been fruitful in ideas for many years in any of the experimental sciences, with the exception of medicine. In the fields of physics, of chemistry, of meteorology, of metallurgy, you must look for the leaders in other countries.

It may be true, although I doubt it, that Germany had the best generals, the best guns, the best ships; she certainly had the largest army and the power to bear upon any point the greatest force; but this condition has passed.

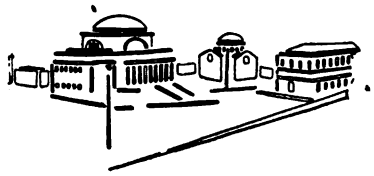
There were two agencies at work in this country which in reality were most powerful sources of German propaganda. One of these was the interpretation given to news from the war by our public journals, and the emphasis placed upon German successes. In part this is due to the lack of realization by the managers of the papers of their responsibility in the matter, but in larger part to that policy of a newspaper office which leaves the writing of the headlines in the hands of inexperienced, comparatively uneducated young men.

The other agency of German propaganda, and a much more vicious one, was the policy adopted by our own government in regard to giving out official information. The whole policy was wrong, and should have been changed. The people have lost confidence in the government agents, and rightly so; they are either optimistic to a ridiculous degree or boastful. What is required is that the government must realize the tremendous responsibility of the office charged with the dissemination of news. There is no man in America too great for this task. He must command the absolute confidence of every one; he must be able to speak the truth and nothing but the truth; he must understand the thousand phases of the war, looked at from a military, a medical, a scientific, a social standpoint; above all he must be allowed to give the American people real information in regard to the efficiency, the achievements of our people and of the Allies.

It is one of the real tragedies that the American people are so often deceived and are not told the truth about so many matters which concern them so vitally. If our people could only have realized the exact situation, Germany would have lost half her power, because in fact the American people were afraid of her, a condition which is absurd.

The time has come for America to recognize the usefulness of the scholar, the thinker, the investigator of science. All the other countries of the world have done so long since. It is only in regard to such experimental sciences as physics and chemistry that there is this failure in this country to appreciate the services of its experts.

Progress In Radio Science



Langmuir's Beat Receiver Circuits

SEVERAL circuits have been patented by Irving Langmuir for the reception of undamped waves by the beat phenomenon. They are shown in the accompanying drawings figures 1, 2 and 3. In figure 1 there is coupled to the plate circuit of the vacuum tube the alternator 12 through the inductance 13 which acts inductively on the plate circuit at coil 11. In the diagram of figure 2, a cascade amplifier is shown where the plate and grid circuits of the first and second valve respectively are coupled through a high resistance 13 shunted by a variable condenser 14. In figure 3 the radio frequency alternator is coupled directly to the antenna through the inductance 22 and 23 and the amplitude of the locally generated current is regulated by the resistance R. This is distinctly necessary for maximum amplification.

Langmuir's explanation for the operation of these circuits is as follows:

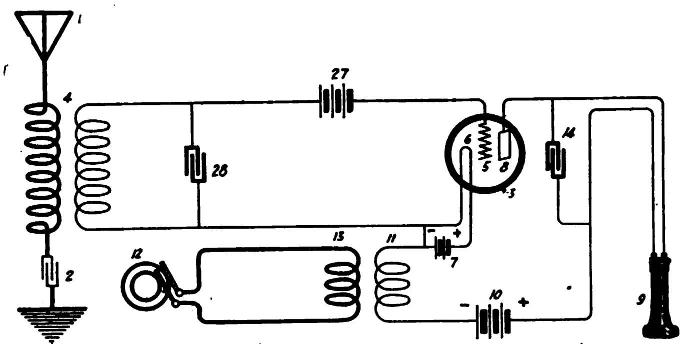


Figure 1—Showing plate circuit of the vacuum tube coupled to alternator

When the frequency of the received waves and of the locally generated waves differ there will be periods when the anode 8 is positive and the grid 5 is positive at the same time. The length of these periods will of course depend upon how near the two sets of waves approach phase opposition. There will also be similar periods when the anode is positive and the grid negative, when the anode is negative and the grid positive, and when the anode is negative and the grid negative. Current will flow freely through the plate circuit, however, only during those periods when the anode is positive and the grid positive. The length of these periods and the amplitude of the current flow will increase from zero when the two waves are in phase, to a maximum when the two sets of waves are directly opposite in phase and will then decrease to zero again. Inasmuch as these periods during which current will flow are of very high frequency, each individual impulse of current will have no effect on the telephone receiver. In combination, however, the impulses will have the effect of a continuous current which gradually increases in amplitude from zero to a maximum value and then decreases again to zero and as a result beats will be heard in the telephone, the frequency of the beats being dependent upon the group frequency of the current impulses set up in the plate circuit and this group frequency in turn being equal to the difference in frequency of the two sets of waves.

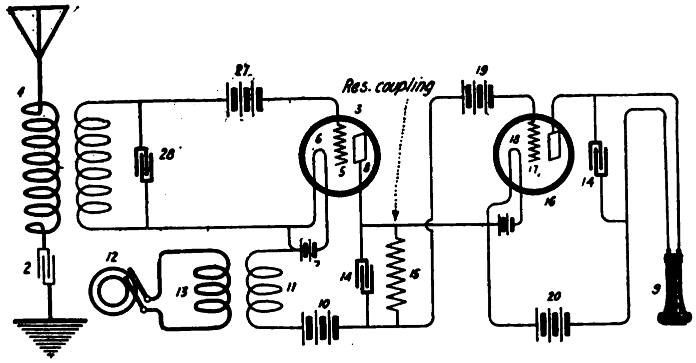


Figure 2—Showing a cascade amplifier

With this arrangement the only signals which can be received are those which are transmitted by means of waves which differ in frequency from those produced by the local source by an amount which is within the range of audibility of an ordinary telephone receiver. Waves which differ in frequency from the locally produced waves by a greater or less amount than the audible frequency of the receiver will produce no effect.

In some cases it may be desirable that the positive half wave of the local source which is impressed upon the anode be made greater than the negative half wave. To provide for this a battery 10 may be employed having its positive pole connected to the anode. The successive impulses of current which flow in the plate circuit, having a high frequency, would be choked back by the inductance of the telephone receiver. To prevent this a condenser 14 may be shunted across the terminals of the receiver. In some cases it will be found desirable also to employ a battery 27 in order that the numerical value of the negative potential imposed upon the grids 5 and 24 may be greater than that of the positive potential. It may even be found advantageous in some cases to make the battery so large that the potential of the grid will always be negative. On the other hand, it may be found desirable in some cases to so connect the battery that a positive potential will be imposed on the grid. It will of course be understood that other suitable forms of current operated devices than a telephone receiver may be used for receiving the signals.

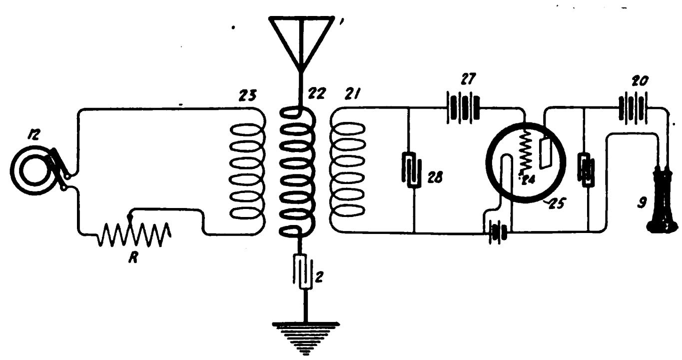


Figure 3—Circuit showing radio frequency alternator coupled directly to antenna

In some cases the energy of the received waves may be so small that the amount of energy which may be controlled thereby in the plate circuit of the tube will be too small to give an easily audible signal in the telephone receiver. In such cases, however, the current fluctuations produced may be easily amplified by the arrangement shown in figure 2. In place of the telephone receiver in the plate circuit in this case we may use a high resistance 15 which is also connected in the grid circuit of a second electron discharge tube 16. This circuit in addition to the grid 17 and the cathode 18 may also include a battery 19. This battery may be so connected that normally the grid 17 has a positive charge. In this case current from the local battery 20 will always flow in the plate circuit of the second tube in which the receiver 9 is included. When current flows through the plate circuit of the first tube the drop of potential in the plate circuit will principally take place in the high resistance 15, and this will cut down the positive charge on the grid 17 due to the battery 19. This will decrease the current flow through the plate circuit of the second tube and the current fluctuations set up in this manner will produce beats in the telephone receiver in a similar manner to that described in connection with figure 1.

The Thermic Telephone as an Oscillation Detector

PROF. DR. HENDRIK ZWAARDEMAKER of Utrecht, Netherlands, has shown a circuit for the reception of electrical oscillations wherein the thermic

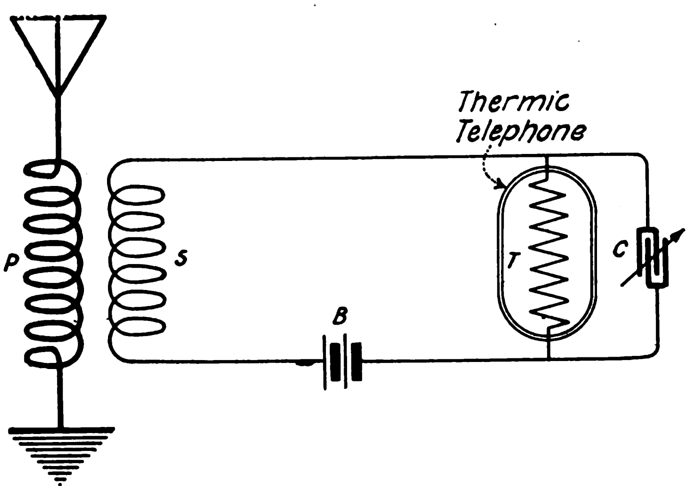


Figure 1—Thermic telephone used as an oscillation detector

telephone is employed as a detector. He has observed that the sensitiveness of the thermic telephone when used as an oscillation detector can be considerably increased when it is polarized, for example, by pre-heating it with a direct current.

In accordance with his invention he corrects the apparatus as shown in the diagram of figure 1 where the primary of an oscillation transformer is indicated at P and the secondary at S, the thermic telephone at T shunted by a variable condenser C. The source of direct current, B, is included in series with secondary winding of the receiving transformer and the telephone T.

Prof. Zwaardemaker insists that the circuit shown in this diagram is sensitive and the apparatus will respond to very weak signals. There must, however, be a certain relation between the resistance of the thermic telephone and that of the secondary coil S. The air space within the thermic telephone should be as small as possible and, in general, its resistance should be rather high.

Dubilier Vibrator Transmitting Sets

A NOVEL apparatus for the production of electrical oscillations has recently been shown by William Dubilier in which a vibrating contact constitutes the spark discharge gap of a closed oscillation circuit. The method of using is shown in the accompanying drawings figures 1, 2, 3 and 4.

The construction of the vibrator is shown in figure 1, where a vibrating element O carries a contact D-1 which makes contact with a stationary electrode D-2. The electromagnetic winding A serves to open and close the contacts D-1 and D-2.

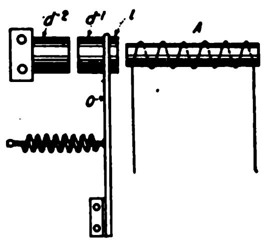


Figure 1—The construction of the vibrator transmitting set

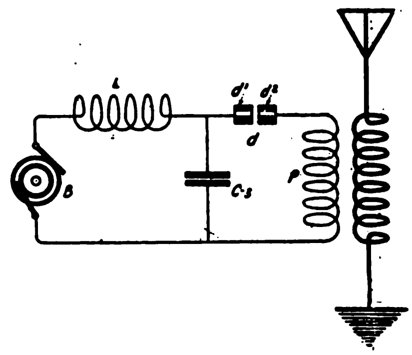


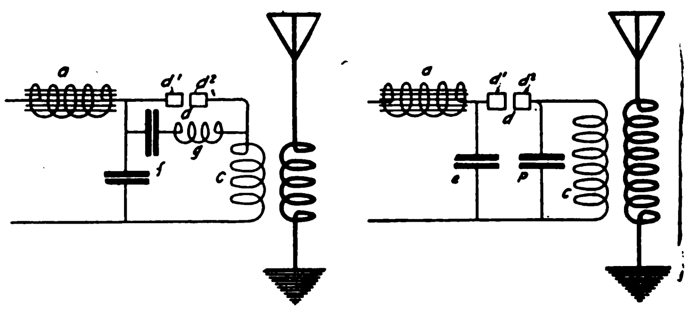
Figure 2—The interrupter spark gap

In the diagram of figure 2, the interrupter spark gap is shown at D, a source of energy at B which may be direct or alternating current, an inductance at L in series with the spark gap and generator, and the primary of the oscillation transformer at P. The complete radio frequency closed circuit comprises the spark gap D, the variable condenser C-3 and the primary P.

The operation of the apparatus has been explained as follows: The current passing from the generator B through the inductance L, through the transformer primary P is broken at contacts D-1 and D-2. The condenser E is in parallel with the gap D and is charged by the action of the arc across the gap. Inductance L prevents the high frequency current set up in a circuit D, C-3, P from traveling back through the generator and also assists in charging the condenser due to its self-induction when the circuit is broken at D.

The inventor declares that the apparatus operates efficiently when the period of vibration of the spring in the vibrator has a selected ratio to the natural frequency of the oscillating circuit D, C-3, P, that is, when its period of vibration is either equal to, or a harmonic of, the natural frequency of the oscillating circuit.

Modified circuits are shown in figures 3 and 4 where a capacity F and an inductance G are placed in parallel with the interrupter D (figure 3). In figure 4, the con-



Figures 3, 4—Modified circuits of the vibrator transmitting set

denser P is placed across the primary of the oscillation transformer C. Inasmuch as a simple electromagnetic vibrator is used to produce oscillations, the cost of manufacture is correspondingly less; and moreover because a closed circuit is obtained in starting the oscillations, a high primary potential is not necessary. A direct current source at low voltage is sufficient to operate the apparatus efficiently, the potential of the oscillating circuit being raised by the opening of the gap D-1 and D-2 and the

inductance A. The inventor states that the apparatus is particularly useful for airplane work. He gives us no information concerning the constants of the circuits employed nor any formula by which the proper proportion of the inductances and capacity are secured.

The inventor mentioned that the circuit produces oscillations having the characteristics of undamped currents for a certain period and a damped or quenched characteristic for a further period.

It would seem from the explanation given that the radio frequency oscillations take place, for example, in circuit D, C-3, P of figure 2 at the time that an arc occurs between the electrodes D-1 and D-2 and at further opening of the electrodes, the arc is extinguished and the oscillations then cease.

Valve Circuits for Radio Reception and the Generation of Sustained Oscillations

IMPROVED circuits for the use of the vacuum valve as a detector of damped and undamped oscillations have been devised by Roy A. Weagant, Chief Engineer of the Marconi Wireless Telegraph Company, as shown in the accompanying figures 1 and 3. Figure 2 is a circuit

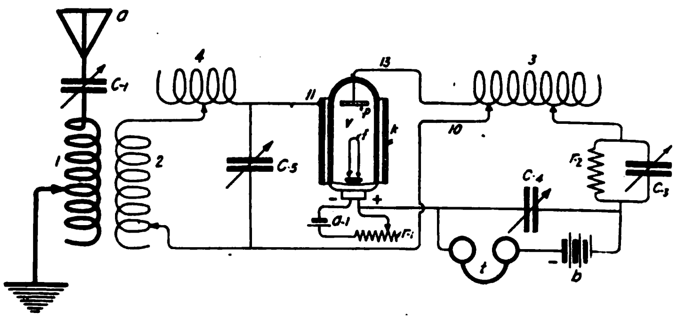


Figure 1—Weagant's circuit for the use of the vacuum valve as a detector of damped and undamped oscillations

which may be utilized for the production of sustained oscillations for transmitting purposes, but which is also applicable for radio reception. The construction of the vacuum tube is shown in figure 4, being an improvement on the well-known Fleming valve patented in 1905. It contains a plate P and a filament F surrounded by a copper sheath K and which is preferably electroplated to the glass. The sheath is of sufficient area to practically enclose both electrodes.

The circuit in figure 3 can be made to generate oscillations in groups at frequencies above or below audibility and therefore can be employed for wireless reception by the beat phenomenon. Generally speaking, the vacuum of the tube when used as in figure 3 is such that the application of 100 volts or less between the plate and filament will produce a visible blue glow or arc like effect. The apparatus shown in figure 1 will generate sinusoidal currents at any frequency and not in groups as the apparatus in figure 3.

An important addition to these circuits is the use of resistance R-2 in the plate circuit, shunted by the variable condenser C-3. When this resistance is very high and of the order of that of the internal resistance of the valve itself, it permits the plate voltage to be adjusted to a higher value than is desirable without its use, enabling the operator to get a critical adjustment of gas ionization so that minute electrical disturbances impressed upon the tube causes a great increase of current through the telephone T. The resistance contributes materially in obtaining the adjustment whereby automatic interruption of the local plate current is obtained enabling the valve to generate alternating currents in groups of damped oscillations.

The inductance 3 in the plate circuit of figure 1 performs several novel and important functions. By careful adjustment of its value, marked amplifications of the incoming signal are obtained. The maximum amplification is usually secured when the frequency of the plate

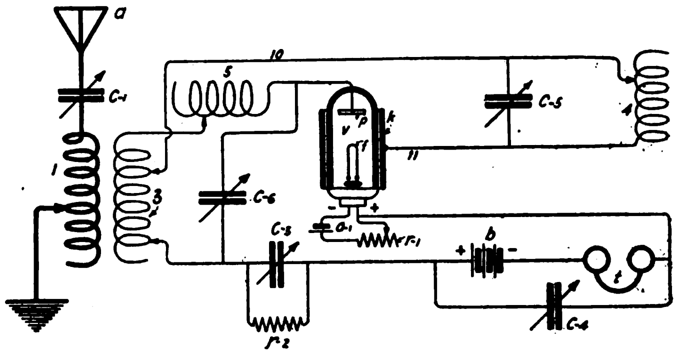


Figure 2—Circuit for producing sustained oscillations for transmitting—is also applicable for radio reception

circuit corresponds closely to that of the associated circuits to which the sheath is connected. By the use of this inductance the valve becomes a generator of sinusoidal oscillations without depending upon any particular critical value of ionization within the bulb. As a matter of fact in contrast to the circuit in which this inductance is not employed, better results are obtained with a tube in which the vacuum is as perfect as possible.

When the apparatus shown in these diagrams is used as a receiver of spark signals, the circuits are tuned so that the valve is just on the verge of oscillation; on the other hand for the reception of undamped waves, the valve is made to oscillate at a frequency slightly different from that of the incoming signal producing a beat current. Another advantage of the inductance element 3 in figure 1 is that it will amplify weak signals whereas with the circuit of figure 3 wherein this inductance is eliminated, there is a minimum strength of signal below which the circuit will not amplify.

The inventor remarks that with the circuit in figure 1 it is possible to start with a signal which is below the low limit of the device when the inductance is not present and amplify it considerably. Added to this, we may have the amplification due to the critical gas ionization within the valve. The combined effects bring about an enormous increase in the original strength of the signals.

Still better signals can be obtained from certain types of valves by providing coupling between plate and secondary windings of the circuit as shown in figure 1 where a wire 10 is tapped off inductance 3. Direct coupling is thus obtained, but inductive or electrostatic coupling might be used as well. In the diagram of figure 2, the

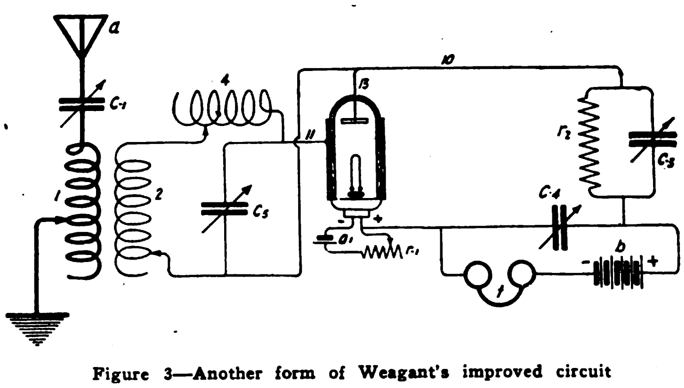


Figure 3—Another form of Weagant's improved circuit

antenna circuit is coupled to the plate circuit inductance 3, the grid circuit being tapped off 3 by wire 10. This circuit also includes inductance 4, shunt condenser C-5 and the sheath K. This circuit constitutes a powerful oscillation generator but may be used for beat reception as well.

Practical Wireless Instruction

A Practical Course for Radio Operators

By Elmer E. Bucher

Director of Instruction, Marconi Institute

PART II—ARTICLE III, OF WARTIME WIRELESS INSTRUCTION

EDITOR'S NOTE—Part 1 of this series of lessons began in the May, 1917, issue of THE WIRELESS AGE. Successive installments were devoted to the fundamental actions of radio transmitting and receiving apparatus for the production and reception of damped oscillations.

Part 2, the present series, will deal with undamped wave generators, including bulb transmitters and receivers for the reception of undamped oscillations. The direction finder and other special appliances employed in radio telegraph work will be treated fundamentally. A discussion of the basic principles of wireless telephony will terminate the series.

The outstanding feature of the lessons has been the absence of cumbersome detail. The course will contain only the essentials required to obtain a government *first grade commercial license certificate* and to supply the knowledge necessary to become a first rate *radio mechanic*.

REFLECTOR ALTERNATORS

(1) In the radio frequency alternators previously described, **radio frequency currents were generated by providing the dynamo rotor with a great number of teeth, the rotating** member being driven at very high velocities. Some of the mechanical and electrical problems involved in such design have been dealt with briefly in the previous issue.

(2) Alexanderson has developed a special radio frequency alternator which we have not described, wherein frequencies up to 200,000 cycles per second were secured by providing **an armature with two-thirds as many slots as the effective number of field poles. Acting on the vernier principle, the frequency of such a machine is equal to the number of field poles on one side multiplied by the speed of the armature per second.**

(3) In the **reflector type** of alternator here to be described, frequencies are multiplied within the same machine. By the use of a relatively low speed armature, radio frequencies up to 60,000 or 80,000 cycles per second can readily be obtained. It is more usual, however, to design such machines for frequencies around 40,000 cycles per second, corresponding to wave lengths between 7,000 and 8,000 meters.

FUNDAMENTAL PRINCIPLE OF THE FREQUENCY MULTIPLYING ALTERNATOR

(1) The student familiar with the operating principle of the **induction motor** is aware that it consists of a **stator** and **rotor.*** In the stator a group of fixed windings are so arranged that a **two** phase current, for example, produces a magnetic field which rotates at an angular velocity determined by the frequency of the alternating current. The **rotor or armature** consists of coils wound in slots, which are short circuited and in which the changing flux generated by the field poles induce a current. The flux generated by the armature current reacts upon the field poles and the armature is set in rotation in a definite direction.

(2) A **rotating magnetic field** can be produced by a polyphase (two or more phases) current or by a single phase current provided that, in the latter case, two field windings are supplied and are so designed that the two resulting magnetic fields **generated thereby are out of phase.**

(3) A single phase current flowing in a single set of field coils of an induction motor does not, however, produce a unidirectional rotating magnetic field, but a field which alternates in direction and changes in intensity. In the case of the induction motor the field would have a tendency to turn the armature first in one direction and then in the opposite direction with no resulting motion. However, the magnetic field resulting from an alternating current flowing in the stator winding may be thought of as **two equal and oppositely rotating fields** which can be put to account in the **multiplication of radio frequencies** within a radio frequency alternator. This is done in the Goldschmidt reflector alternator.

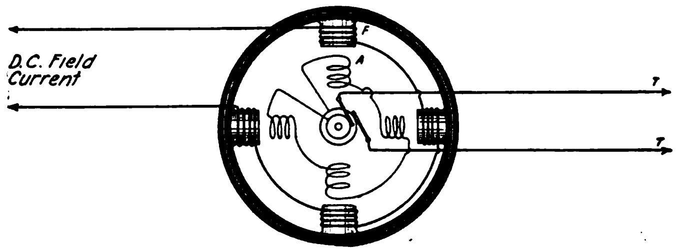


Figure 193

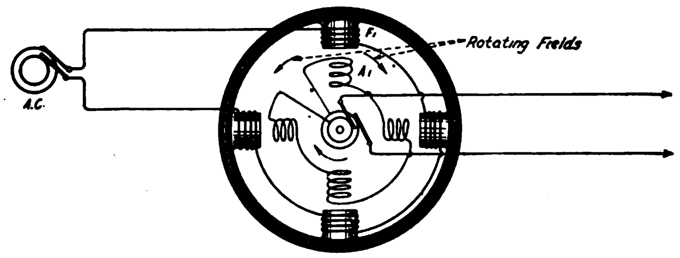


Figure 194

OBJECT OF THE DIAGRAM

To show how an alternating current may be doubled in a generator, the field coils of which are excited by alternating current.

DESCRIPTION OF THE DRAWINGS

Figure 193 represents a simple alternator, with four field poles F, fed by DC current from an external source. The armature coils are indicated at A, the collector rings at N and the external circuit at T. The speed of armature, for purposes of illustration, is assumed to be 1800 revolutions per minute.

Figure 194 is a similar diagram, but in this case the field windings are excited by alternating current of the frequency that would be obtained in figure 193, with DC excitation current, and an armature speed of 1800 R.P.M.

OPERATION

The speed of the armature is 30 revolutions per second and therefore in one complete revolution there will be 4 x 30 or 120 changes of flux through its windings. This will induce 120 alternations of current in the armature coils, giving a frequency of 60 cycles per second.

The terminals of this armature T are assumed to be connected to the terminals of the field coils in figure 194. Current of a frequency of 60 cycles will flow in the field circuit and the resulting magnetic field can be thought of as **two equal magnetic fields rotating in opposite directions.**

If, for example, the armature turns clock-wise, at a speed of 30 revolutions per second, no cutting will result in respect to the component of the field which rotates clock-wise and therefore no current will be induced in the armature coils A′, but in respect to the field which rotates in the opposite direction it is clear that the relative motion is **twice the velocity** of the armature, because the **field rotates in one direction at a given velocity and the armature rotates in the opposite direc-**

(*Continued on page* 19, *first column*)

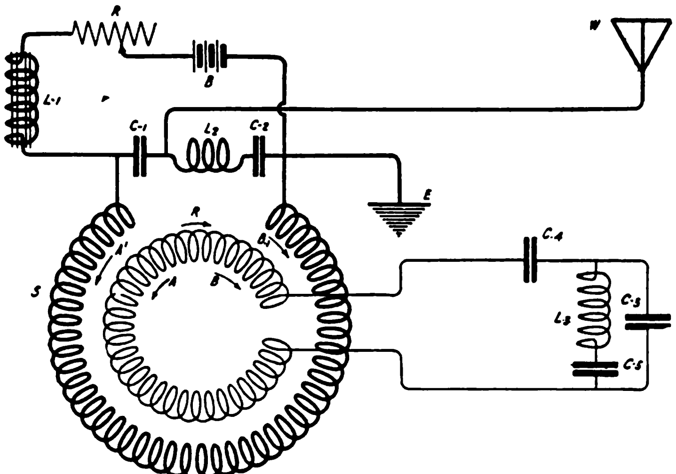


Figure 195

OBJECT OF THE DIAGRAM

To indicate the fundamental principle of circuits of Goldschmidt's radio frequency alternator.

DESCRIPTION OF THE DRAWING

A stationary DC field winding known as the **stator** is indicated at S and the **rotor** or **armature** at R.

Winding S is set into excitation by a DC source B in series with which is the **rheostat** R and the **impedance** L-1.

Since the impedance of the rotor and stator circuits of the alternator must be reduced to a minimum for four frequencies, the rotor and stator terminals are short circuited by the inductances and capacities shown. For example:

In the case of the rotor:

Condenser C-4, inductance L-3, condenser C-5 short circuit the rotor R for the frequency of 15,000 cycles. (That is, inductance L-3 and condenser C-5, short circuit R and C-4).

Condensers C-4 and C-3 short circuit the rotor for 45,000 cycles.

In the case of the stator:

Condenser C-1, inductance L-2 and condenser C-2 short circuit the stator S for the frequency of 30,000 cycles.

Condenser C-1 and the electrostatic capacity of the antenna to earth, short circuit stator S for 60,000 cycles—the desired antenna frequency.

It is to be noted that condenser C-4 alone would short circuit the rotor, but in order that a separate path may be supplied for the current of 45,000 cycles, a second circuit of the same magnitude as R, C-4, namely L-3, C-5 is connected in series. By this connection we have doubled the inductance and halved the capacity, making no change in the fundamental frequency of the circuit. The rotor remains on short circuit to the fundamental frequency of 15,000 cycles per second and another path through C-3 is provided for the frequency of 45,000 cycles without changing the tuning for the other frequency.

The same explanation applies to the stator, the product of S and C-1 equalling the product of L-2 and C-2.

OPERATION

For purposes of illustration we have indicated the two oppositely rotating magnetic fields of the stator and the rotor by the arrows A' and B' for the stator, and A and B for the rotor.

The stator S is provided with the correct number of poles so that the initial frequency of the current generated in the rotor R is 15,000 cycles per second. This current flows through C-4, L-3 and C-5.

The magnetic field of the rotor resulting from this current can be thought of as two oppositely rotating fields represented by the devices A and B. If the armature be assumed to rotate clock-wise, component A (since it is opposite to the direction of rotation) will produce no effect upon the stator winding because the velocity of the rotating field and the armature are the same and in opposite directions, but the component B rotates in the same direction as the armature and at the same velocity. We may therefore consider the field of the rotor to be produced by an alternating current of a frequency N rotating at a frequency N and the component B will cut the stator S at a frequency of 2N or 30,000 cycles. This current is increased in magnitude by short circuiting the armature with condenser C-1, inductance L-2 and condenser C-2.

With reference to the stator S, the current of 2N produces oppositely rotating fields indicated by the devices A' B'. The rotor R cuts through B' at one-half the velocity of B' (which is equal to 2N) inducing in R a frequency of 15,000 cycles or N, which frequency neutralizes the former frequency of N. In respect to component A' the relative motion is obviously 3N, for the armature rotates in one direction at a velocity equal to the frequency N and the component A' in the opposite direction at a velocity equal to 2N. The resulting frequency is therefore 3N (or 45,000 cycles per second) which flows through condensers C-4 and C-3.

We may now resolve the current of 3N in the rotor R, into two oppositely rotating fields, using again the devices A and B. We must keep in mind that the armature rotates clockwise at a velocity equal to the frequency N. In respect to component A the relative cutting upon the stator is 3N—N or 2N (30,000 cycles per second) which current neutralizes the former current of 2N in the stator.

In respect to component B, we may consider it as a field of 3N rotating at a frequency N and its velocity in respect to the stator is 4N or 60,000 cycles. This current flows through C-1, the circuit being completed by the electrostatic capacity of the antenna.

SPECIAL REMARKS

(1) Reflector alternators of 200 kw. output have been constructed and placed in actual operation. They are driven at speeds between 3,000 and 4,000 revolutions per minute and are supplied with 360 field poles.

(2) The rotor is made of fine iron laminations .002 inch in thickness; the laminations being insulated from one another by thin sheets of paper. In fact, the rotor of the machine is one-third paper. The air gap clearance between the rotor and stator is .03 inches, which requires very accurate design throughout.

(3) The stator and rotor windings are similar in design, consisting of one conductor per pole. As in other radio frequency alternators U shaped windings are employed. In order to prevent excessive rises of potential in the alternator circuits, the rotor and stator windings are wound in sections permitting either a series or a parallel connection. The conductor of the rotor and stator is made up of a number of very fine wires in the form of a cable, the wires being insulated from one another by an enamel coating.

(4) **Signaling** is accomplished either **by change of inductance** in the antenna circuit, as in the arc system, thereby tuning and detuning the antenna circuit each time the key is pressed, or the key may be inserted in series with DC excitation circuit. Special precautions had to be taken in the latter method of signaling for each time the field windings were demagnetized, the load was taken off the driving motor, causing a great variation in speed, throwing the machine out of resonance with the antenna circuit. To offset this, a double contact telegraph key is provided which, when the DC excitation circuit is closed, inserts a resistance in series with the field circuit of the driving motor. The reduction of field current increases the driving force just sufficiently to maintain normal speed under change of load.

(5) The reflector alternator is not suitable for radio transmission at variable wave lengths. It is evident that a rapid change from one frequency to another cannot be obtained and beyond this the best efficiency is obtained at some constant speed. Alternators of this type are only applicable to transmission between land stations, operated at fixed wave lengths. Viewed from all standpoints, it is doubtful whether they will have any considerable commercial application.

(6) Complete resonance between the antenna circuit and the desired alternator frequency is established by an aerial tuning inductance.

(*Continued from page* 18)

tion at the same velocity. There will, therefore, flow in the armature of figure 194 a current of **double frequency.** This current can be fed to the field windings of another generator and the frequency again doubled, but as will be shown this multiplication can take place within the same machine.

SPECIAL REMARKS

(1) In figure 194 the armature A' is rotated at synchronous speed. If it revolves out of synchronism with the two magnetic components of the stationary field coils, it can be shown that two frequencies will be generated in the armature; that is, if the frequency of the field current is N_1, and the speed of armature is such that if the field windings were excited by DC current, its frequency would be of different value N_2, then the frequencies of the two resulting currents in the armature circuit will be N_1+N_2, and $N_1—N_2$.

(2) In the Goldschmidt reflector alternator, owing to the fact that the generation of radio frequency currents is involved, tuned circuits must be provided in order to reduce the impedance of the armature and field circuits for several frequencies. The phenomenon of rotating fields is employed as in the above illustration and the armature is driven at such speeds as will permit the desired multiplication of frequencies to take place.

Radio Frequency Changers

Reported Progress in Their Application to Radio-Telegraphic and Telephonic Communication

By E. E. Bucher

Director of Instruction, Marconi Institute

(*Continued from the December,* 1918, *issue of* The Wireless Age)

Control of Antenna Currents

IN order to control the antenna current in the Arco-Meissner frequency changer system, it has been found of advantage to divide the auxiliary magnetizing circuits as in figure 17. Here the last group of frequency changers is indicated at C with the primary windings P, S, and the secondary windings P′, S′. A source of direct current B through the windings EE nearly saturates the core of the yokes Y and Y′. The circuits are arranged so that with the degree of magnetization afforded by this circuit, the antenna circuit including the secondaries P′ and S′ is slightly off resonance with the radio frequency changers. Then by closing the key K, the yokes

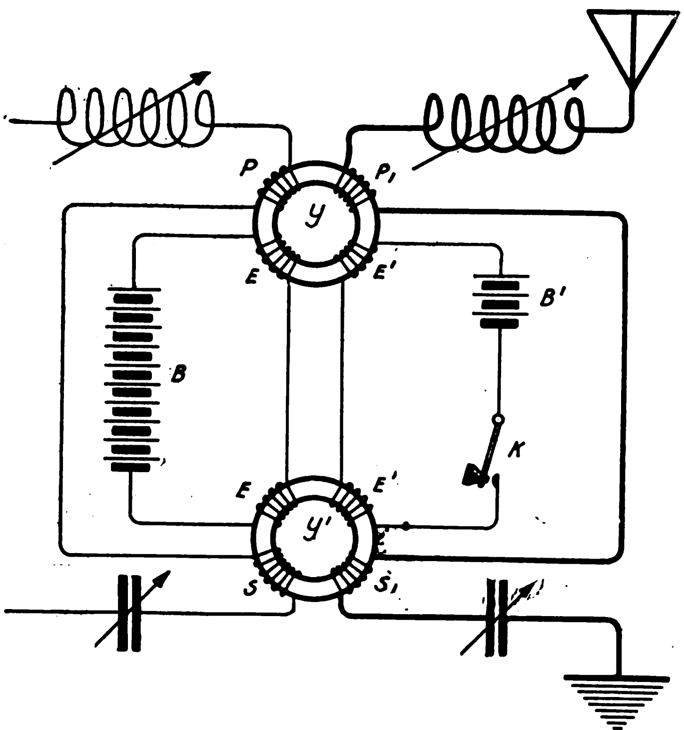


Figure 17—Split key control circuit of the Arco-Meissner system

are further magnetized from a separate source of direct current B′ thereby establishing complete resonance with the antenna system. The coils E′ E′ are therefore designed to provide the additional magnetizing force required to saturate the core. This connection gives the advantage that the electrical control of the saturation circuit and the signaling circuit are separate.

Signaling at tone frequencies may be accomplished by substituting for the key K a magnetic interrupter or for wireless telephony a microphone for the transmission of speech. The inventors' remark that this separation of two magnetizing circuits is of particular advantage in case tone frequencies are secured by means of alternating current at audible frequencies circulating through excitation windings E′.

Universal Type of Transmitter

We have shown in the previous article, the circuits of a complete station provided with means for the production of undamped oscillations for telegraphy or telephony, or for the production of groups of damped oscillations all from the same source of current—a radio frequency generator. The diagram which reappears in figure 18 will now be described more in detail. All these arrangements are confined to the same piece of apparatus and by means of a selective switch, not shown, the connections can be shifted from one system to the other as desired. For example, in figure 18 the yokes Y-1 and Y-2 constituting the last step of a radio frequency changer system carry the excitation windings E′ fed by the source of direct current B in series with which are the choking inductances I, the regulating resistance R, the shunt key resistance R-3, a telegraphic signaling key K-4, a separate telegraphic signaling key K-5 in series with which is the buzzer B-2. A special load circuit or dummy aerial is provided by windings S-5 and S-6, inductance L-1, the ballast R the variable condenser C-1, and the switch K-3. Several telephonic microphones M connected in series parallel and each group in series with an inductive resistance R-4 are shown. The source of direct current is the battery B-3. It is further to be observed that the primary winding of the telephone transformer P-7 is connected to each group of microphones through a condenser C-7 so that the speech current flowing through P-7 acting upon secondary S-8 contains no DC component but only the speech variation component.

If it is now desired to telegraph with undamped oscillations, the circuit from the DC source B to the coils E′ is closed. The strength of the excitation current is regulated by the resistance R to the desired degree of core saturation. If then the key K-4 is manipulated so as to cut resistance R-3 in and out of the circuit, the desired signals are produced by alternately tuning and detuning the alternator and antenna circuits in the way explained heretofore.

If at the same time the constants of the load circuit including the ballast R, are properly adjusted and the switch K-2 is closed, the load on the generator remains constant for it is automatically shifted from the artificial aerial to the antenna proper; that is, the constants of the circuit are so selected that when the antenna circuit including windings S-4 and S-3 is in resonance with the impressed radio frequency, the inductance of S-5 and S-6 is changed to throw the dummy circuits out of resonance and vice-versa. This tuning and detuning, may it be repeated, is accomplished by changes of flux through the iron cores. The provision of such means for maintaining a constant load on the generator is particularly essential in the use of high powers but in transmitters involving the use of small amounts of energy, satisfactory

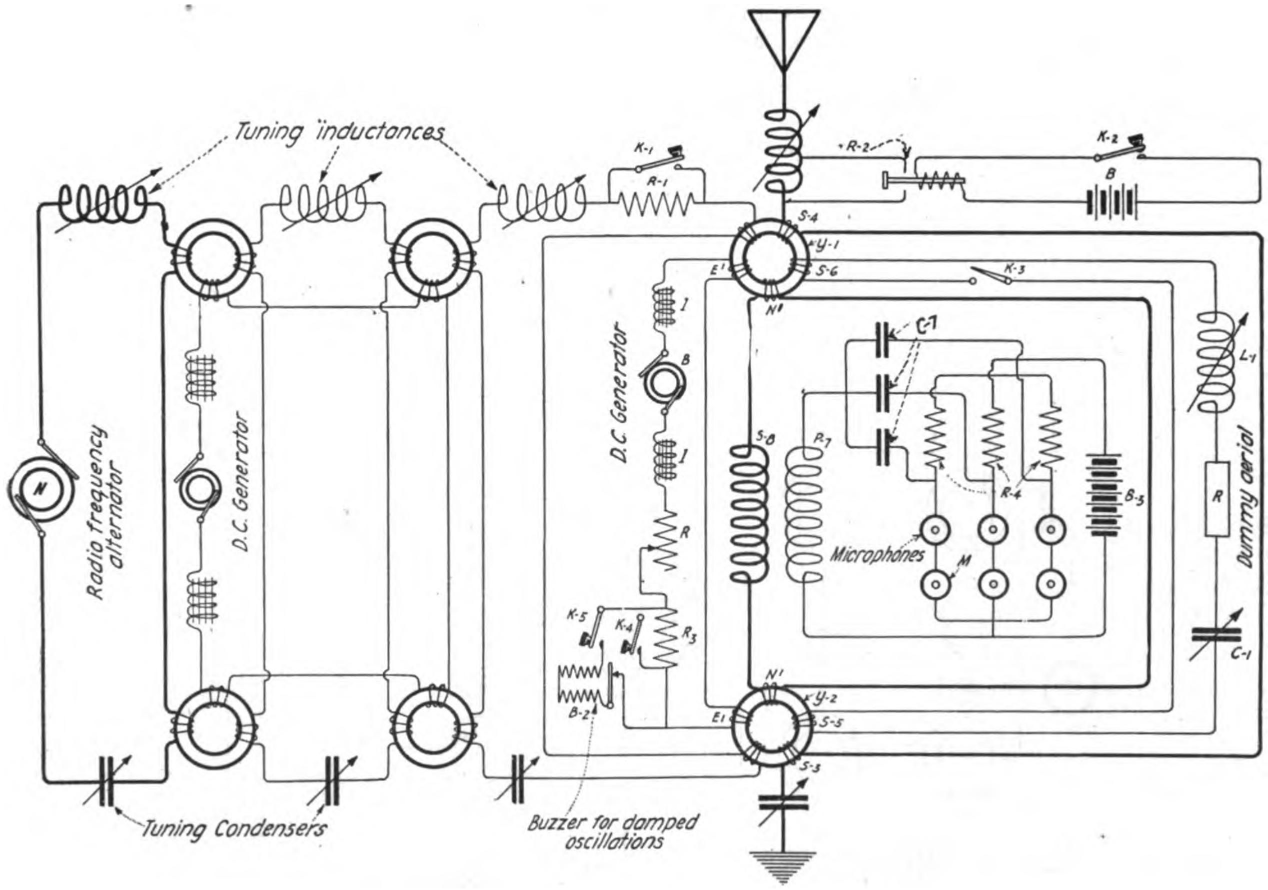


Figure 18—Frequency changer transmitting system for wireless telephony, or telegraphy by damped or undamped oscillations

signaling may be accomplished by opening and closing the keys K-1 and K-2 as described in the previous article. Moreover it is desirable to provide both means of signaling so that in case one becomes inoperative an alternative arrangement is available.

If it is desired to generate damped oscillations at an audio frequency, key K-5 is opened and closed causing the buzzer B-2 to be set in operation. The resulting variation of the excitation current through the coils E′ through the operation of the buzzer, causes sufficient change of impedance in the radio frequency changers to vary greatly the antenna current. Thus the antenna will radiate oscillations which can be detected by detectors suitable to the translation of damped oscillations only. In place of the buzzer, alternating current may be superimposed on the winding E′ to produce damped oscillations at audible frequencies.

THE CIRCUITS FOR WIRELESS TELEPHONY

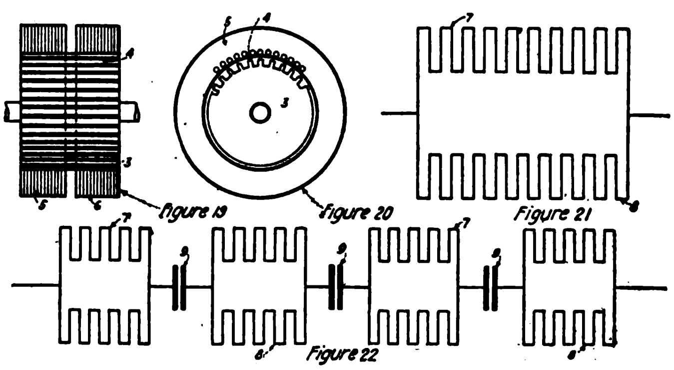
To use this apparatus for speech transmission, the resistance R is first adjusted to a suitable value, and then the microphones M, connected to the transformer P-7, S-8, are put into operation. R is adjusted to a critical point on the characteristic magnetization curve so that the speech currents through the primary P-7 set up similar currents in the secondary windings S-8 and the coils N, N. The resulting change in flux through the yokes Y-1 and Y-2 will cause a relatively great change in the strength of the antenna current.

A close survey of the microphone circuit will show that in each branch two microphones are connected in series but three branches are connected in parallel. Each of the three banks is fed from the source B-3, through their individual resistances R-4. Across each microphone is shunted the primary P-7 of the telephone transformer P-7, S-8 each branch including one of the condensers C-7.

The operation of the microphonic control is as follows: Whenever the microphone resistance increases, the current through its series resistance remains nearly constant, but the current through the microphone diminishes. The excess current resulting therefrom flows through the primary winding P-7 and the corresponding condenser.

REGARDING THE DESIGN OF THE RADIO FREQUENCY ALTERNATORS

After many experiments Arco and Meissner have found that a type of radio frequency alternator having



Figures 19, 20, 21, 22—Constructional details of the dynamo rotor

an air gap the longitudinal axis of which has the direction of the axis of the rotor gives the greatest efficiency. This construction permits the use of a small air gap which is a matter of importance on account of the large number of field poles. It has the further advantage of increasing the output of the machine.

The rotor indicated at 3 in figures 19 and 20 consists of a toothed wheel without windings driven at a very

high speed. The poles which are formed by the teeth are of equal polarity and the generation of radio frequency currents is secured by an undulation of flux and not by a reversal thereof which is the case of any ordinary alternator.

It has been found of particular advantage to divide the generator symmetrically in the middle at right-angles to the rotor axis so that equal stator halves 5 and 6 as in figure 19 are obtained.

The continous wave windings of the two winding halves 7 and 8 of figure 21 are preferably arranged in parallel so as to maintain the generator's self-induction and the generator voltage developed by resonance within the winding at a low value. This precaution is particularly necessary because on account of the large number of poles in high frequency generators it is difficult to insulate the armature windings.

In order to further reduce the difficulties of insulation due to high voltages, each stator half in generators of high power is divided into an equal number of sections and the two corresponding sections of the two armature halves are in each case arranged in parallel as a group as shown in figure 22.

The resulting groups are preferably arranged in series with condensers 9 placed between each group as indicated in the drawing. This arrangement reduces materially the equalizing currents which occur in the parallel arrangement of the armature halves, due to inequalities in the winding. Beyond this the maximum voltage between the entire winding and the stator is no greater than the voltage between an individual partial winding and the stator.

It is also advisable in the case of large energy outputs to provide means for conducting cooling water through the iron and stator. This has been provided for in the latest types of equipment.

VALVE ARRANGEMENTS OF THE RADIO FREQUENCY CHANGERS

Finally it may be mentioned that it is possible to use the well-known valve connections for the radio frequency changers shown in figure 23. They are symmetrically inserted into the four branches of a Wheatstone bridge. In the middle branch of the bridge of the group A, is inserted the primary winding of a transformer P acting on the secondary S the complete circuit of which is tuned to currents of double frequency. The current in S may be fed to a further group of radio frequency changers the secondaries of which are directly connected to the antenna.

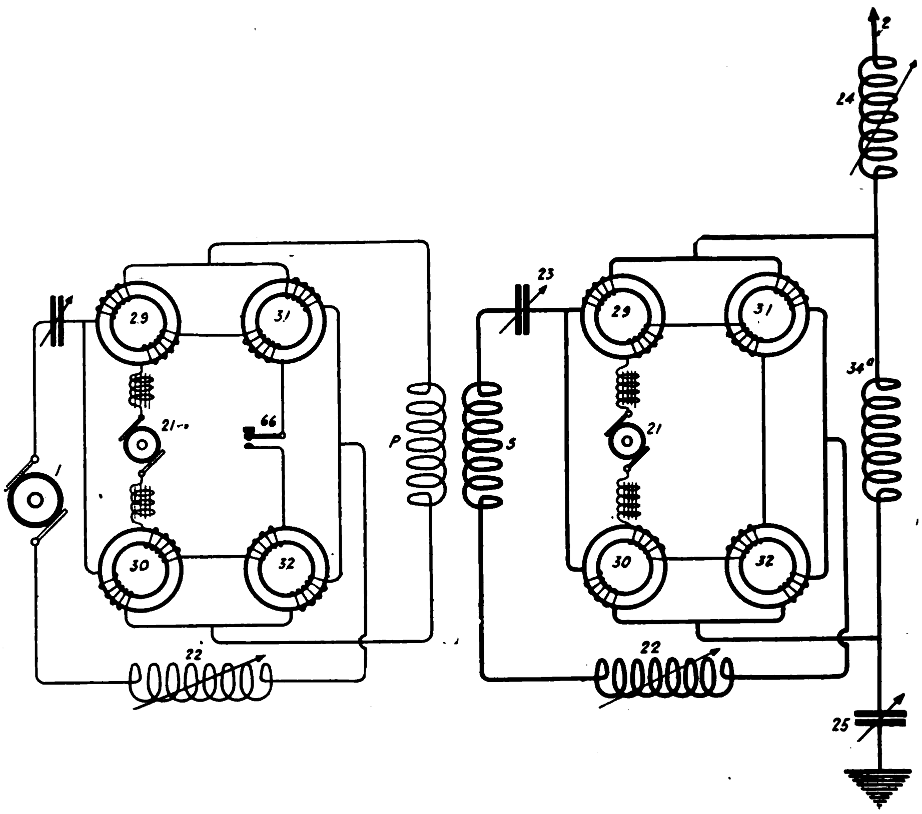


Figure 23—Valve connection of frequency changers

As an alternative arrangement two of these mono-inductive resistances may be substituted by an induction coil from the middle of which a third conductor is branched off as shown in figure 24. Here the middle conductor P is connected to the middle of the armature winding of the generator 1. In this case the two remaining mono-inductive resistances or rather the windings A and B are arranged on one yoke, Y-1, which also carries the two direct current windings D-1 and D-2.

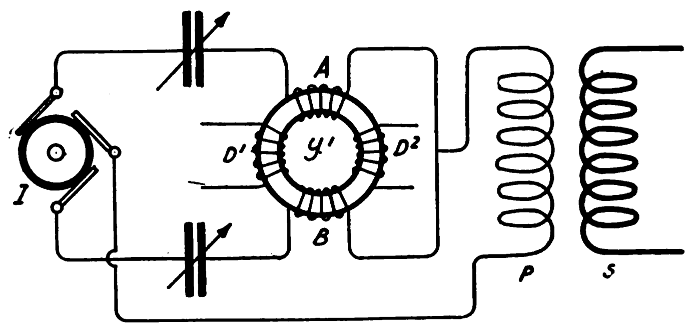


Figure 24—Alternative method of frequency doubling

The Monthly Service Bulletin of the NATIONAL WIRELESS ASSOCIATION

Founded to promote the best interests of radio communication among wireless amateurs in America

GUGLIELMO MARCONI, President — J. ANDREW WHITE, Acting President — ALONZO FOGAL, JR., Secretary

Headquarters, 25 Elm St., New York

In Memory of "9YA."

ACCORDING to word received from the War Department, Lieut. Lyman (Pete) Case has been missing in action since August 14. Later advices report that he was in a bombing airplane squadron and met in collision with a German machine in the neighborhood of Metz. His airplane was seen to crash to the ground from an altitude of 12,000 feet.

Lieut. Lyman Case, reported missing in action, a former well-known N. W. A. member

Lieut. Case will be well remembered by members of the N. W. A. and other amateurs of the United States as the former operator of 9YA, of the State University of Iowa, Iowa City. He was one of the most able assistants in all of the national relay programs which were executed prior to the declaration of war. He could see the handwriting on the wall and knew that sooner or later the Government would need a great number of young men, skilled in the radio art, and devoted nearly all of his spare time in teaching everyone within signaling distance of 9YA, the wireless code. Regularly, he sent out baseball, football and boat race results by wireless. These bulletins were copied as far east as Pittsburgh.

Lieut. Case was born August 7, 1896, in Nokomis, Ill. His parents live in Lamoni, Iowa, one brother being Dr. M. W. Case of Davenport, Iowa. He was one of the first Iowa boys to enter the Officer's Training School at Fort Snelling, in May, 1917. While there, he volunteered for the Aviation Section, Signal Corps, and was sent to Toronto, Canada, in July. From there he was sent to Camp Borden, Texas, at which place, in November, he did his first flying. He was transferred to Garden City the 1st of January and sailed for England January 31. In Scotland, for several weeks Lieut. Case engaged in daily flying. He wrote numerous letters explaining how valuable his training as an amateur had been to him. He was later sent to France and was one of the American aviators who were organized with the Royal Flying Corps. It has not been possible to secure information as to where Lieut. Case was buried.

It will be appreciated if all the wireless amateurs of the country will join with the writer in sending letters of condolence to his family in their bereavement. WM. H. KIRWAN.

VICTORY!
Get Ready for Re-Opening of Stations

Washington, D. C., Dec. 14, 1918.

WIRELESS PRESS:

Hold up publication of "Age" for insertion of following notice:

To All Members:

From all indications the bill in Congress to blot out the amateur has failed. The amazing war record of American amateurs has been openly recognized before the Congressional Committee and an amendment to the bill has been introduced permitting amateur stations to reopen on approximately the same basis as before the war. The hearings on the bill will not close for some days, but it appears that the Government ownership proposals are doomed. Amateur communication will probably be resumed on conclusion of peace as before, under the present law, the act of August, 1912.

The victory is cause for mutual congratulation among all amateurs and best wishes to the field at large are extended for the new year.

Special Committee, N. W. A.
J. ANDREW WHITE,
ALONZO FOGAL, JR.,
E. E. BUCHER,

RADIO STATION, 24 BALLOON CO.
FRANCE.

The Editor, WIRELESS AGE—Kindly pub ish this in your valuable magazine:

Radio men in the U. S. service "over there" are dying to receive your last month's WIRELESS AGE. What do you say, old man? Send yours soon. The last one I saw over here was last March. Hoping to hear from someone in regard to this soon, I am Yours,

JOSEPH E. ENGSTROM,
Radio Station, 24 Balloon Co., A.E.F. Air Service.

Antenna, Radiation and Ground Resistance

I SUBMIT herewith a table prepared from actual tests showing the relation of antenna resistance, radiation resistance and ground resistance of a particular aerial over a change of wave length from 400 to 2,000 meters. The antenna had a capacity of .00126 microfarads, inductance of 43 microhenrys and a fundamental wave length of 440 meters.

Wave Length	Antenna Resistance	Radiation Resistance	Ground Resistance
400	26.0	14.0	6.5
500	19.0	9.0	7.5
600	16.0	6.7	9.0
700	14.9	4.9	10.1
800	15.0	3.5	12.0
900	15.8	3.0	13.5
1000	16.9	2.5	14.8
1100	18.0	2.0	16.0
1200	19.0	1.8	17.5
1300	20.2	1.7	19.0
1400	21.5	1.6	20.2
1500	22.5	1.5	21.9
1600	24.0	1.4	23.0
1700	25.5	1.3	24.6
1800	27.0	1.2	26.0
1900	28.4	1.1	27.8
2000	30.0	1.0	28.7

This table indicates that the ground resistance increases gradually for each increase in wave length, but the radiation and antenna resistance drop around 700 meters. The antenna resistance then increases again. The radiation resistance decreases gradually until the wave length of 1100 meters is reached, whereupon it decreases more slowly and at a more uniform rate. The most effective radiation would take place at wave lengths between 600 and 700 meters, with this particular aerial.—

E. T. JONES—*Louisiana.*

Protests With a Point

Evils of a Legislative Boomerang

THE bill, H. R. 13159, introduced by Congressman Alexander and referred to his committee, calls for outspoken protest from every amateur wireless man in the United States. Senate bill, S. 5036, which appears to be a duplicate, equally calls for vigorous opposition.

These bills make wireless an out-and-out Government monopoly. The Navy would, by the bills' provisions, come into possession and operation of the whole American radio communication system.

A provision is made for experiment and technical training school stations. No mention is made of amateur stations. That the omission was intentional is clear, because the present law distinctly classifies these as: general amateur stations, special amateur stations and restricted amateur stations.

Perhaps some genius might design an amateur station that would not transmit signals outside his state boundaries or receive outside signals—and be permitted to operate. But this is a ridiculous and valueless assumption. Yet that is the only opportunity the present bill offers. It frankly and unreservedly gives the Government permanent possession of radio and its unrestricted operation.

Two conclusions are reached by reading the Alexander bill. First, that the Navy expects by throwing the sop permitting experiment and technical schools to operate, to overcome the objections of leading scientists that experimental progress in an infant art would be killed off by Government monopoly. Second, that the Navy considers amateur wireless of no real or potential value, so purposes to wipe it out.

Against the opinion of the framers of this bill is arrayed a sizable body of serious students in the art, to which the Government is under great obligations. The officers of the National Wireless Association, with a membership of representative character and proportions, feel qualified to speak the unanimous sentiment of this great body of amateurs succinctly as follows:

The Alexander bill is a high-handed and unjustified attempt to trespass on the rights of American citizens and a legislative boomerang that will do incalculable damage to its undoubted exponents, the Navy itself.

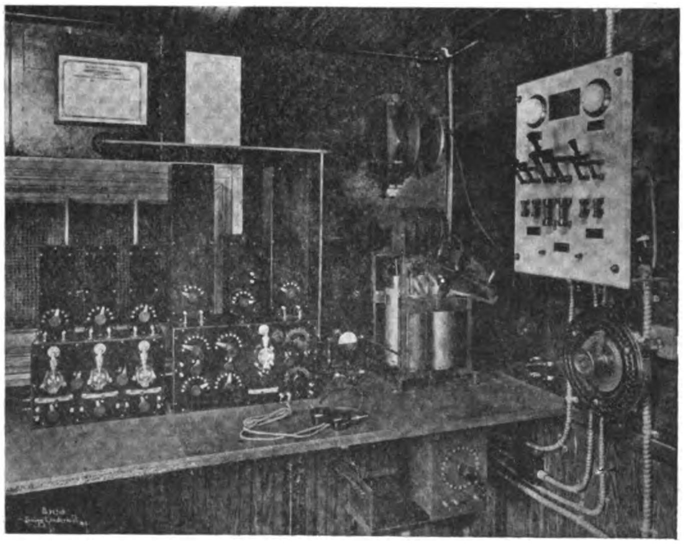
On behalf of its membership, the officers of the Association call for complete rejection of the provisions of H. R. 13159 and S. 5036, on the grounds that enactment will absolutely stifle amateur radio communication and thereby bring to a permanent end the development of an experimental group under which have been conducted activities of proved value to the nation.

President Wilson approves this measure, according to newspaper reports. The reasons for the alleged approval are not given. Wherefore it is inconceivable to amateur radio men that he has a true appreciation of the deliberate intention to end amateur work in wireless. The President's views on this subject are on record in this office. On March 1, 1916, he wrote to the Association an endorsement of its activities, the organization of amateurs in his opinion, being "undoubtedly a valuable asset to the nation." Further on the same subject, he wrote: "The value of such an organization in co-ordinating the activities of a large number of specially qualified young men along carefully planned lines will be of great benefit not only in an educational way to the young men themselves but also to the country at large when the necessity for their employment, individually or as an organization, may develop."

That is the substance of the letter. The necessity for employment which President Wilson anticipated, came a year later, in the emergency of war. And the amateurs made good—away beyond the most sanguine expectations.

In return for which service and fulfillment of promise, we are given to understand that their stations in which they prepared for the emergency, are to be permanently silenced and the pursuit of their studies in radio brought to an end!

Such an attitude is inconceivable from the world's leading exponent of freedom for all peoples. American amateurs will not be satisfied that the President's endorsement of the Alexander bill was given with the full understanding that it killed off amateur activities unless the proponents of the bill can introduce indisputable evidence to that effect.



Amateur Wireless Station Constructed by Alfred Henry Grebe

It is difficult also to recognize the obvious truth that the bill provides for the Navy to monopolize radio communication. Amateurs have been led to believe that the Navy looked upon them as useful. Captain Bullard, the first officer who administered the high office of directing naval radio communications, is on record, before the hearings in committee in January, 1917, with a statement that the amateurs should be left alone, that, to quote his exact words: "As far as the Navy is concerned, its activities are toward the uplift of the amateurs and not to destroy them in any way." Captain Bullard accepted honorary vice-presidency in this association, too, and in other ways indicated the sincerity of this viewpoint. His successor, Captain Todd, also in a letter to the Association, in October, 1916, protested against a member's view that proposed legislation "endangered our right to operate our wireless stations," stating this statement was ill-timed and misleading.

Secretary of the Navy Daniels also called in December, 1915, for the names and addresses of members, stating then that the need might arise in the Navy for many more men. It is an historical fact, now, that the need did arise and that the amateurs responded to the call.

In fact, during the war period, and preceding it, repeated requests were received for publication of appeals to secure the enlistment of amateurs, urgently needed for both Army and Navy.

Now that these amateurs have served their useful purpose, it is proposed that as a class they be exterminated. This presupposes a viewpoint that the emergency having passed, a future need will not arise. Blot out the amateur, therefore; he has served; cast him aside now.

It does not appear to enter into the question that the stimulus of wireless telegraphy as an art has a foundation and a source of personnel supply in those who begin their investigation by the home-study and experiment method. The provisions of the bill ignore the potential value of thus continuing to expand the field. It is sought, rather, that all future activity center about the radio establishment of the Government—that the development of a communication method still in a transitory state from an art to a science, be committed to the hands of a few workers on the Government payroll or in technical schools or professional laboratories. The individual worker, in a phrase, is to be suppressed. No opportunity is to be given for independent investigation and possible invention by the youth of the nation—in spite of the fact that the discovery of wireless telegraphy was made by Marconi when a boy just out of his 'teens!

The amateur of America is not typified, as many would like to have the lay public believe, by an irresponsible boy tinkering with tin-can apparatus in a backyard. As a class, the amateur is better represented by a number of commissioned Army and Navy officers called to the colors from civilian pursuits and engaged in designing administration work, and duties of the line of great responsibility. In all cases he is not wearing a uniform; but is serving also as inspector or expert radio aide. It follows, then, that the skill of these amateurs in radio is considerable. It is indisputable, also, that this skill was acquired over a long period of individual experimenting, not through the intensive training facilities offered by the Government in emergency.

The amateur who, for physical reasons or because of dependents, couldn't don olive drab or navy blue, has also served. A generous response followed the appeal to this Association to supply instructors for radio and buzzer operators, 20,000 being required by the Signal Corps. Men who volunteered for this work, conducted by the Federal Board for Vocational Education, included graduate electrical engineers, power plant superintendents and commercial wire chiefs—men in their early forties—and all amateurs in wireless.

As a further illustration of how the amateur was viewed by the military establishment, appeals were made to this Association for highly skilled men for the radio intelligence section, it being specifically stated that students in schools and beginners would not do. Men of the requisite qualifications were supplied from amateur ranks.

These special duties proved beyond question that in wartime the nation could not properly function in radio without men of experience. The experience dealt with in the instances cited is 100 per cent. amateur. Yet it is now proposed that the work of these men in radio be stopped short, that no more amateurs be developed or present ones be permitted to continue their experimental work!

A monopoly of the air, as this bill conceives it, is preposterous. No student of the radio art will concede that scientific development is feasible if left solely to employes of this Government, or any other. Nor does the cry of "interference" awaken any supporting response. It is in every way as ridiculous to forbid vehicular traffic on highways because Government business is being transported over them, as it is to forbid freedom of the air because of Government communication.

As a war measure, silencing and shutting down amateurs was right and proper. There was no protest. But in time of peace, such autocratic proceedings will meet with nation-wide protest.

The matter of so-called interference has been discussed at length many times. **The broad statement that what little interference existed was caused by improper adjustment of receivers and transmitters and poor operation, covers the whole argument. The present law provides, by fine and revocation of license, adequate protection from this annoyance, which, as a matter of fact, exists in infinitesimal quantity.**

It will probably be argued that amateur wireless must be killed off so secrecy may be maintained. Technical advancements insure the reduction of unintentional eavesdropping to an unimportant minimum. The present law provides fine and imprisonment for divulging the contents of a message. What more can be accomplished? Deliberate interception of wireless messages can be carried on secretly no matter what restrictions the law may provide.

It is impossible to insure entire secrecy in any field of communication. All wireless messages in transmission are not easily available to any who care to listen. And it is wholly unfair to the radio art to deliberately foster that opinion in the public mind. The true situation is simply this: Telephone, telegraph and cable lines can be tapped just as readily as wireless can be intercepted. The party-line telephone and the telegraph sounder exactly illustrate the conditions.

Pertinent to the subject of wilfully disclosing the contents of messages, there is another consideration. If the Alexander bill becomes a law 100 per cent. of the radio communications of commerce are placed in the hands of naval operators. These men are citizens of the United States and of course subject to its laws. Should the inference be drawn that they are less susceptible to temptation in disclosing commercial secrets than are other citizens—the amateurs? There are laws against crime, but crime is committed. Is it a fair assumption that Government employes are immune, and the only potential lawbreakers are private citizens?

The matter of secrecy appears from any angle, unimportant, if not irrelevant, in a discussion of reasons for legislating the amateur out of existence.

While not a single valid reason appears why the amateur field should be wiped out, it is clearly demonstrable that the attainments of these individual workers are an appreciable contribution.

Prior to the war the advances in radio which were contributed by Navy men were negligible. All improvements of basic character originated entirely outside the Governmental establishment. The naval achievements consist entirely of detailed variations in

design of apparatus to suit military needs. Wartime improvements are another matter entirely; the amateurs, scientists and commercial engineers and the Government experts all became a unit working to a common end. Whatever developments followed only serve to emphasize the importance of the civilian radio man. Thus the contributions to the art from Government sources must stand examination on progress before the war. And, it is repeated, not a single basic achievement can be presented, whereas the broad field of experimental workers, by invention, incontestably builded the art to a highly efficient state.

The assumption that with Government ownership in force, a hand-picked personnel of experts can be drawn into the ranks of official radio will not stand the test. There is no profit in inventing where there is federal domination, comparable to the reward which commercial industry offers. There is no future for the amateur in production engineering where commercial companies will have but one customer, the U. S. Government, and prices thus become arbitrary. Patents will have a solely speculative value because the Government uses any invention it requires—and refers the inventor to the Court of Claims to await its award, if any.

Naturally, the experimental field will dwindle down to minute proportions. And the United States—the promoter of freedom—will face the sad spectacle of having repressed by official action a great body of earnest, thinking young men from continuing a self-determined course of educational study. It cannot be argued that this form of education will be adequately provided for by technical institutions of learning. The incentive to gain having been removed, or woefully restricted, professions other than radio engineering will appear vastly more enticing to the student.

It is a fact that in the senior engineering class at the Columbia University, at the outbreak of the war, 50 per cent. of the student body were former radio amateurs. Their amateur work had induced them to follow electrical engineering as an eventual profession.

All educational institutions are required to appeal for students; they must be attracted; they do not come to the higher halls of learning unless they are encouraged. And it is submitted that amateur wireless is an extremely valuable means of introduction to the study of electrical science.

The demolition of the amateur field in radio with one legislative blow is a serious matter. As near as can be ascertained there were, prior to the war, 175,000 amateurs in the United States. The figures are based upon the sales records of manufacturers of electrical supplies which show that the purchases of receiving equipment were about in the proportion of 25 receivers to 1 transmitter. Transmitting stations only requiring licenses, and 7,000 of these having been issued, it is evident that the total in round numbers represents 175,000 amateurs. Since these stations will show a fair average investment of $50 each, there is an aggregate investment involved of something like eight and three-quarter million dollars.

But that sizable sum of money represents more than a loss in dollars and cents. The assembly of these stations necessitated a stupendous amount of labor. And with this labor came a still greater acquirement of technical knowledge—that expensive commodity, education—gained by first hand familiarity in assembling and constructing intricate electrical devices.

Is it to be abandoned by a non-advantageous legislative act? Can the future of the existing amateur field be cut off short without due consideration of its claims of valuable achievement?

In the war just ended, amateur wireless saved the Government several million dollars. It has been established that the cost of training men for military service in radio was about $1,000 per man. In the case of the amateur the training period was materially shortened, the per capita cost being reduced perhaps two-thirds. And it is also of interest that the total facilities available in universities and technical schools could provide for but 150,000 men. The existing amateur field was larger by 25,000.

Utility is another consideration worthy of note. The achievement of Mr. Apgar, an amateur, in disclosing to the Department of Justice the unneutral messages sent out by the Sayville station—resulting in its seizure—calls for recognition. It has never been denied that Texas and California amateurs detected the same type of communication over the Mexican border. Nor can the credit be placed anywhere but in the amateur's hands for the maintenance of communication during the floods in the Middle West in 1914 and 1915. It is indisputable also that an amateur saved the situation in Hamilton, Ohio, in 1913. During that flood Mr. Swain, an amateur, was the only man available for communication. He connected up a key and sounder and supplied the only means of communication from the east side of the city, thus securing food, clothing and other supplies urgently needed. Mr. Swain's interest in amateur wireless qualified him to accomplish the feat. The work in flooded districts did not end there. Up to the date of our entry into the war, the station of the Doron brothers in the same city was employed in reporting the stages of river rise whenever the possibility of a flood was imminent. Throughout the entire country drained by the Miami River this station was regularly consulted for reports whenever the river began to rise.

Amateur wireless has a distinctly recognized place in agricultural areas also. Regular distribution of weather reports has been a voluntary service rendered in outlying districts where six to twenty-four hours are required for the mail to arrive from the nearest office of the Weather Bureau. That farming districts require and appreciate this service of amateurs needs no further comment when one reflects upon the problematical value of reports arriving by mail six to twenty-four hours after issuance.

It is also well known that nearly every big ranch in the West had its amateur station for the same reason.

In summary, therefore, it is contended that irreparable damage will be done to the interests of the nation at large if the Alexander bill becomes a law. It is also advanced that the radio art will stagnate under a policy of Government ownership and imperialistic domination of radio communication with all powers vested in a department organized basically for making war.

This Association knows that it voices the full sentiments of the amateurs of the United States in expressing this protest. Thousands of amateurs are still in uniform and are thus effectively silenced. But the protest is supported by the large majority of these patriots also, the Association is confident, for many have been consulted and the desire for permitting amateur radio communication to re-open under the present law (the Act of August 13, 1912) has been unanimously expressed.

NATIONAL WIRELESS ASSOCIATION,
J. ANDREW WHITE,
Acting President.

Some Technical Aspects of Government Wireless Ownership

A FAVORED argument of the proponents of Government ownership to enlist legislative support is the assumption that because a wireless telegram has no guiding wire but employs the all-pervading ether as a conducting medium, it is entirely beyond the control of the sender; therefore it will set up interference to the operation of other stations. The impression is fostered that such messages find their way into the apparatus of stations for which they are not intended, setting up a veritable bedlam which nothing but Government ownership can still. Only through Government proprietorship, the argument continues, can these cross currents be prevented, because federal authorities can then dictate to the last detail the daily operation and acts of every radio station in the nation.

To the lay mind these statements may be impressive, but they fail in the true light of the engineering facts. The ether carries myriads of vibrations simultaneously without interference. It is generally accepted today by leading scientists that heat, light, X-rays and the electric waves of wireless telegraphy are nothing more than different rates of vibration of the ether. The radio engineer may select one of several thousand rates of vibration and employ his choice in communicating between a given set of stations without interfering with the operation of other stations. It should be made clear that the frequency of vibration of the wave motion sent out by a wireless transmitter has a certain definite value, and the receiving instrument must be adjusted or tuned for exactly the same rate of vibration in order that communication may be established.

This is exactly the method by which mutual interference between wireless stations is prevented. There is no reason to believe that the Government radio men are better qualified for selecting and using frequencies of vibration than are the experts of commercial or amateur radio.

There is no objection to Government regulation and supervision, but there are innumerable objections to sole Government ownership. Under the existing laws, Government, commercial and amateur stations are provided with standard wave lengths, which in themselves eliminate the basic problems of interference. Everyday wireless operation has demonstrated that by wisely selecting the wave lengths to be employed, hundreds upon hundreds of wireless stations may be operated without any interference whatsoever.

Before enacting any drastic statutes eliminating the amateur from the program, Congress should investigate and value the benefits which our Government derived in the recent war from the services of the amateur wireless operator. It should be known that experimentation in this art is the best promoter of scientific education of the day. The degree of skill required to operate wireless apparatus should be appreciated, as well as the value of the amateurs' experience in continuing the art of wireless telegraphy through the past few years.

A second so-called argument advanced by Government ownership advocates, is that the amateur wireless operator can, if he chooses, copy down commercial and Government messages, thereby coming into possession of confidential communications which might be employed in a harmful manner.

It is this committee's purpose to prove that the amateur wireless experimenter, obeying existing laws, will not interfere with official or commercial message traffic.

The pre-war regulations were sufficiently stringent to meet all technical requirements for the prevention of interference. Under the existing law amateur wireless transmitting sets are restricted to the wave length of 200 meters, and power input of one-half kilowatt for stations within five miles of a Government station, and to one kilowatt for stations outside a prescribed zone. A further requirement is that the decrement of the radiated wave be no greater than 0.2 per complete cycle, the latter being a precaution to ensure a sharp wave, thus decreasing the possibility of interference or cross currents at any Government receiving station.

The greater proportion of official and commercial communications are dispatched at wave lengths above 600 meters. Certain stations are operated at lower wave lengths—down to 300 meters—but since electric wave radiation at the shorter wave lengths has not proven as effective as at 600 meters and above, the use is not general.

Receiving apparatus at Government stations is ordinarily tuned to wave lengths of 600 meters or greater; the amateur operates on a wave length of 200 meters. With the improvements that have been effected in wireless transmitting and receiving apparatus during the past few years, the possibility of experimental stations interfering with the operation of Government stations is so small that it is negligible.

This committee's contentions are based on the following facts:

It is a comparatively simple matter to design an amateur transmitting set to radiate waves with a decrement as low as .05 per complete cycle. Add to this sharpness of radiation the selectivity obtainable with modern vacuum tube detectors and associated circuits, and it will be found that between stations with wave lengths having the 400 meter difference between 200 and 600 meters (or even a lesser difference) the possibility of interference is reduced to a minimum.

Two types of receiving circuits have recently been developed that further reduce interference at the receiving station:—the **regenerative beat receiver** and the **cascade radio frequency amplifier.** Either system installed in a Government station will eliminate cross currents. In fact, the selectivity of the cascade circuit is so fine that it requires very precise adjustment on the part of the receiving operator to pick out the desired signal.

If, under all circumstances, it is necessary that amateur transmitting stations comply in every detail with the law in respect to the sharpness and purity of the wave radiated from transmitters, no complaint, then, can arise from Government stations. With a pure wave emission a one-half kilowatt amateur station may be operated within a mile of a Government station equipped with modern receiving apparatus of the type aforementioned and not cause the slightest interference. To insure this freedom from interference it is only necessary for the Government to exercise its authority under the present law; viz., see to it that the amateur station radiates a pure wave.

In support of the statement that a 200 meter amateur station will not interfere with the operation of Government stations, is an exact knowledge of radio engineering principles and a series of actual tests made under practical conditions. It follows that if a Government station is interfered with by a 200 meter amateur transmitting set, the apparatus at the Government station is poorly designed or improperly handled.

It must be admitted that the damped wave spark transmitter adjusted for low decrements afford sharpness of tuning nearly equal to continuous wave generators, but if the decrement of the spark transmitter is still employed as an argument, the amateur may resort to more modern types of undamped wave transmitters, thereby removing the last vestige of justifiable complaint about interference.

Greatly improved apparatus has been developed during the war. The vacuum tube transmitting set, for example, has been highly perfected and is one which amateurs may employ to the greatest advantage. It is possible to operate these transmitters at the wave length of 200 meters with a power output of a fractional amount of a kilowatt of energy. Because with such transmitters genuine undamped waves will be radiated, the factor of selectivity will be vastly increased over the old type of transmitter, removing to the lowest degree the possibility of setting up interference with a Government station. It is unquestioned that vacuum tube transmitters will be adopted by amateur experimenters in increasing numbers and within a short time pre-war types of spark transmitters will be in minority use.

The United States Government already has had through previous legislation control of the operation of amateur wireless stations. In the event that any of them did not comply with the law they were reported and the regulations were enforced by the Government's local inspector operating under the Department of Commerce. Violations of the law in pre-war times were limited to a few instances, and were entirely unintentional. A reminder from the Government inspector proved sufficient to place the offending experimenter on the straight and narrow path. There is no reason to believe that the amateur will in the future get out of the control of the Government authorities.

Now, on the subject of a supposed second argument: What possible harm can be occasioned by the presence of the amateur eavesdropper? What confidential information would he by chance be likely to hear in carrying on his experimental work? A few Government orders, many commercial messages and ship position reports! But he is already enjoined by Government legislation from divulging the contents of such communications, and any one whose interests might be injured by his disclosures would have full recourse to the courts of law for damages. To the best of this committee's knowledge, not a single instance of the kind occurred during five years of regulated amateur operation.

It does not appear that there is any danger to business interests through the reception of messages by the eavesdropper; business men do not send confidential communications in plain English over the telephone, cable or wireless. It cannot be said that the wires or cables are strictly secret and it should be known that long distance wireless telegraphy in the immediate future will be conducted at speeds of 200 words or more per minute. Apparatus has already been perfected that will permit such rapid transmission and reception. Ear reception is limited to 30 or 40 words per minute. So the amateur has little chance of ascertaining the contents of high speed messages, unless he is provided with a mechanically elaborate—very costly—high speed recorder capable of taking down these signals.

With long distance radio communication carried on at 200 words per minute and important business messages from ship to shore or shore to ship transmitted in cipher or code, about the only messages that the eavesdropper will be likely to hear would be somewhat to this effect:

MARY SMITH, ALTOONA: SHIP DOCKS AT TEN O'CLOCK. MEET ME.—JOHN.

Inadvertent disclosure of the contents of such a communication would be somewhat analogous to the immensely harmful practice of country postmasters reading incoming postcards.

What benefits would a Government monopoly give to the nation at large? None whatsoever. It would invest the powers of control in the hands of a favored few. It would destroy all incentive for the inventive genius of our country to conduct research towards improvement of wireless communication. Forfeited would be the hundred-and-one commercial applications of the art which would naturally follow under private ownership and freedom of operation. It would give the Government the power to say, "thus far and no further." The advance of the individual would not rest on merit, but upon bureaucratic favoritism. It would destroy the enthusiasm characteristic of American enterprise to develop a new art. It would completely wipe out a branch of experimentation that has done more to further the interests of technical education than any other discovery heretofore made. Such a procedure on the part of our Government is utterly un-American and contrary to all precedent.

Who is responsible for the great inventions in wireless telegraphy in the United States? Surely they cannot be credited to Government initiative. Who, it may well be asked, perfected the Radio Frequency Alternator, the Poulsen Arc Generator, the Vacuum Tube Transmitter, the Regenerative Beat Receiver, the Vacuum Tube Wireless Telephone Transmitter, the Direction Finder, the Weagant Static Eliminator, and numerous other appliances which have advanced the art in the past few years? Every single one of these inventions were perfected by private citizens. Many of these men were former amateurs, and in many cases it was the observations of these men as amateurs which spurred them on to make deeper investigations resulting in the solution of some difficult scientific problem. Who knows but that some amateur wireless experimenter will bring forth a new idea that will revolutionize the art?

Of all the inventions of the past half century, none has created such universal interest as wireless telegraphy. Resulting experiments have been of immense benefit to mankind because they have tended to promote technical education, a matter of paramount importance to America's industrial future.

Amateur radio operation requires a study of fundamental principles of electricity. An insight into the electrical and mechanical sciences is thus gained that most likely would not be induced by any other line of experimentation. It has been demonstrated that the amateur's keenness in manipulating wireless telegraphy equipment was of untold benefit to the Government in the recent war. Through his experience the amateur relieved the Government instructor of a great deal of unnecessary delay in training enlisted men to operate the Government's wireless apparatus.

We have shown ourselves to be a resourceful nation in the event of a national crisis such as arose in the recent war. Our shops, our laboratories, colleges and universities were turned into a united war machine to carry out the plans of the military establishment. Where would we have stood had not the amateur experimenter and the scientist responded so whole-

heartedly to the call? Whatever argument may be presented that the amateur's small wireless station might prove detrimental to our peace-time naval and military program, fails before the more forceful one that a small army of amateur wireless operators will again be of inestimable advantage in possible future emergencies. The amateur wireless experimenter should be left alone. Our country may be only too glad to utilize his services at a most unexpected moment.

TECHNICAL COMMITTEE, N.W.A.

A Plea for the Radio Amateur

IT is greatly to be hoped and urgently to be desired that the bill now pending in Congress for the control of radio communication during peace times, and tending to prohibit amateur wireless communication, should be defeated.

No government created the art of radio communication. The art and science of radio communication were both brought into existence by the efforts of amateurs, amateur electricians and physicists. It ill-becomes representatives of a government like ours that they should seek now to confiscate from the amateurs of the country that facility which amateurs produced.

The right to use the air we breathe for talking by sound-waves is unchallenged to all citizens of our globe. Why should the right to talk through the air by invisible electro-magnetic moves be denied!

Everyone will agree that when an amateur abuses his privilege of free speech by radio, through the ether, so as to interfere objectionably with the rights of others, the offending amateur should be proceeded against according to law; but within the proper limits, the amateur should be encouraged and aided by the government, not discouraged and repressed. During the last fifteen years, a number of improvements in radio communication have come about through the enthusiasm and studies of amateur radio operators. Now that the government is able to utilize these improvements, the proponents of this bill will seek to confiscate them, to the exclusion of all future amateurs.

The privilege of listening in, and also, within reasonable limits, of joining in the world's conversation through the all-pervading ether is a godsend to our race and time. No one but an amateur, or person who has practiced radio communication, can fully appreciate the magnitude of that privilege—the opportunity of listening in succession to all the multitude of messages borne upon the ocean of electromagnetic waves. **To destroy that privilege would be one of the most cruel acts of history, worthy only of the Bolsheviki.** During war time, there has been no noticeable complaint on the part of the amateurs of the country, at being debarred from use of the radio apparatus that, in many cases, they had built up with great pains by their own hands. Now that peace is being restored, it should be allowed to restore its blessings to the radio amateur.

The cultivating and civilizing influence on all our people, especially our young amateurs, of putting themselves into intellectual communion with fellow radio telegraphists all over the world, is a great asset to the country. The privilege of entering into the great electromagnetic ocean of intellectual exchange is of the greatest educative value. Anyone who has enjoyed the installation and operation of an amateur radio station, knows that this is a free education in itself. It is an occupation that not only develops the soul of the individual by giving him an insight into the mysteries of electromagnetics and the mysteries of long-distance transmission of ideas; but also tends to make him or her a more useful individual by becoming conversant with the international code of Morse signals. During the war we have trained, at great expense, thousands of young men to become operators, in order to perform more usefully the military tasks assigned to them. This training in signaling will be, also, of great value to those who have acquired it, in times of peace. By excluding the radio amateur from his natural rights and privileges as a dweller in the universal atmosphere, a relatively large number of self-trained Morse operators will be lost.

Radio communication is still a very young art, although it has been developing by leaps and bounds. There is an enormous amount of work yet to be done, in order to perfect and simplify the art of radio communication by telegraph and telephone. Every encouragement should be offered to all the young amateurs throughout the world to help in this development work. If they are excluded by force of government authority, the work of development will be confined to a mere handful of government selected men. Even on the assumption that the best men are employed in the selected group, it is evident that with the aid of all the amateurs in addition, they will be able to accomplish much more.

The great boon of radio communication should be left, as far as possible, free to all, under suitable legal restrictions against abuse of the privilege. Only in that way will inventors be stimulated to work at the various problems presented by the art. If the entire business of radio communication is vested in the hands of the government, the market for the sale of improvements by the work of inventors will be so restricted that very few will have the courage to persevere.

Experience during the recent war has abundantly shown that there will be no difficulty in the immediate acquisition by the military authorities of all the radio plants of the country, amateur or professional, when the emergency arises. Because, for that reason, the government is properly entitled to lay its hands upon all radio communication in war, it owes to the public the right of free communication in times of peace.

A world in which the voice of the radio amateur is hushed by the power of the law, and in which no one has the right to speech except the army or the navy, would be a world no longer free.

A. E. KENNELLY, Sc.D., A.M.,
Vice-President, N. W. A.,
Professor of Electrical Engineering,
Massachusetts Institute of Technology,
Past President, Institute of Radio Engineers,
Past President, American Institute of Electrical Engineers,
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Radio Amateur Work as a Scientific Mind Builder

PRESUMABLY the chief reason why men no longer burrow holes in the sides of hills to serve as their permanent residences is because it is one of the finer human traits to question and experiment. To make a shelter out of boughs proves the possession not only of a spirit of inquiry as to the possibility of improving on the muddy cave, but also a marked tendency to try something which may turn out to be a real improvement.

One of the most personally pleasant survivals of the cave man's attitude to question and try is the experimental attitude of the modern radio amateur.

Presumably (and fortunately) there never has been an amateur who was not a human question mark, or who was ever satisfied with his knowledge of what was going on in the apparatus used by him. The continual series of changes made by the up-to-date amateur show how alive he has been and also his need for verifying experimentally any point concerning which he is in doubt.

Since a questioning and experimental attitude is a real national asset, particularly in a free nation like ours, it is encouraging to note how widely the activities of the amateur have spread. An occasional word of caution is necessary, however. To question even thoroughly demonstrated facts is destructive. To change and experiment with equipment until all its usefulness is destroyed is absurd. The amount of experimental work carried out by the amateur necessarily should be limited by his discreet and reasonable use of apparatus and by the guard which he must set on himself in avoiding interference with other amateurs. Above all, he must bear in mind the grimly serious nature of the traffic handled by commercial and governmental stations, and use every means to avoid interfering, for his pleasure, with what is in their case a life-and-death or, at least, a bread-and-butter matter.

There is a personal aspect of the work of the amateur which has considerable attractiveness. Chatting with one's friends by radio certainly promotes a sort of broad neighborliness. A man's point of view cannot fail to be broadened by having in his circle of acquaintances a number of equally enthusiastic amateurs, centered not only in neighboring towns but even in adjacent states or further. The "small town" attitude melts away at the touch of the radio key and the amateur's world broadens out with the increasing range of his transmitter.

On the other hand, this increased range of the amateur may, and unfortunately sometimes does, bring him within the ken of commercial receiving stations in his neighborhood. A proper amateur code of ethics will at once prompt him to reduce power rather than to risk interference with important commercial or governmental messages.

America has always been proud of Yankee ingenuity and manual skill. Dexterous handling is surely fostered by radio experiments. Aside from the delicate and accurate touch on the key required for careful sending, there is a great amount of delicate adjustment of couplings, of variable condensers, of crystal points, and similar equipment. All of these help toward the development of the observing eye and a careful and dependable hand. The amateur develops a pride in the neat workmanship and excellent finish of his set and in its careful lay-out and business-like appearance. He develops ingenuity in meeting unusual experimental difficulties, in improvising new equipment even out of discarded odds and ends. Such resourcefulness is well worth while.

The amateur may purposely or inadvertently become a listener-in on private communications from ship to shore. This unusual privilege obviously carries with it a proper obligation to maintain a generously co-operative spirit, calling for the exercise of proper caution that there be no interruption of this traffic or annoyance caused to its dispatchers. It is a grave question whether indiscriminate listening-in to private communications will last indefinitely. High speed or code transmission may play a part in the communication of the future.

The amateur of the United States will therefore do well to raise the standard of what may be called his "profession" by joining the leading engineering institute in the field and affiliating himself with local amateur socities as well. He will thus keep in touch with all modern improvements and through the medium of the higher grade radio magazines, know exactly what is going on. In this way he will not lag behind the times, nor unconsciously cause trouble to the commercial stations.

We may hope under these conditions to have a steady stream of radio engineering recruits drawn from the ranks of the amateur with a resulting advantage to the entire field.

Alfred N. Goldsmith, Ph.D.,
Vice-President, N. W. A.

Director of Radiotelegraphic and Radiotelephonic Laboratory, College of the City of New York;
Editor, Proceedings of the Institute of Radio Engineers.

From the American Radio Relay League

A VERY serious situation has arisen. Unless all of us amateurs act quickly, a law will be passed in Washington which will wipe amateur wireless completely out.

I know you will find this hard to believe, **BUT IT IS SO.** A bill has been introduced in both the House and the Senate which may prohibit amateur wireless. It is **GOVERNMENT OWNERSHIP APPLIED EVEN TO OUR AMATEUR WIRELESS,** and whoever introduced it is guilty of gross lack of appreciation of the patriotism of those amateurs who, not waiting to be drafted, **VOLUNTEERED** in those first dangerous days of unpreparedness when our Army and Navy were in desperate need of young men who knew wireless. Not only are these young men ignored, but the bill is likely to be pushed through while they are absent in their country's service and rendered mute by military regulations, and forbidden to appeal on their own behalf.

Our American Radio Relay League officers are fighting hard, but we are only a handful. Alone, we cannot make the Congressmen in Washington appreciate the importance of amateur wireless. You must help us. You positively must write a letter immediately, and see that it is mailed before the sun goes down tonight to your Representative and also your Senator in Congress. You should say something like this:

We protest against the injury that will be done many young men of this country if House Bill 13159 and Senate Bill 5036, which may prohibit amateur wireless, are passed without a full and free hearing. It will take time for the amateurs to present their case because most of them are in the Army or Navy and away from home. The Bills should be held up until the amateurs can be informed of what threatens them.

If you do not know the name and address of your Representative or Senator, your Postmaster will tell you. You must help, and today, or good-bye to all amateur wireless and the valuable experience and education that comes with it. Who knows but what a future Edison, Westinghouse or Marconi is in the making in your very house if he is allowed to continue his amateur wireless work.

THE AMERICAN RADIO RELAY LEAGUE, INC.

Hiram Percy Maxim,
President.

The Amateur as an Army and Navy Expert

YOUR attention is seriously called to a bill, H. R. 13159, "To further regulate radio communication," introduced by Mr. Alexander on Nov. 21, 1918, which was referred to the Committee on the Merchant Marine and Fisheries.

From articles which have appeared in the press, this bill was interpreted by many concerned to merely give the Secretary of the Navy the power to operate or maintain all commercial radio stations on land or on permanently moored vessels now in existence within the jurisdiction of the United States or any of its possessions, and that the commonly-called **"radio amateur"** would still be allowed to erect, maintain or operate for experimental and private use a radio station—if properly licensed, as provided by the Act to Regulate Radio Communication, approved August 13, 1912.

A glance at an official copy of Mr. Alexander's bill shows that the **"radio amateur"** was not even mentioned.

In the Act of 1912 a distinction was made between different classes of land stations as follows:

(1) Public Service Station (a) general (b) limited.
(2) Limited Commercial Stations.
(3) Experimental Stations for the development of radio communication.
(4) Technical and Training School Stations.
(5) General Amateur Stations.
(6) Special Amateur Stations.
(7) Restricted Amateur Stations.

On the present bill, H. R. 13159, the amateur station is ignored. Evidently Mr. Alexander does not know the important part which the "radio amateurs" have played in the war for democracy.

After the United States declared war on Germany our Government sent out a call for several thousand **trained radio operators** which were needed at once in various branches of the Army and the Navy. The result was that more than five thousand radio **amateurs**, skilled in the operation of modern radio apparatus, enlisted or accepted civilian positions in the Army or the Navy.

If Mr. Alexander had excluded the radio amateur from his bill of 1912, this radio personnel would not have been available for the great emergency. Dependable radio operators and radio experts capable of operating and erecting modern complicated radio apparatus cannot be trained over night; their skill rested on years of constant study and experimenting.

Statistics compiled two years ago showed that there were over 100,000 radio **amateurs** in the United States, not taking into account the boys and others who were merely playing with radio. Amateurs, as they are called, are the real experts, for they work at wireless for the love of it; they are building new apparatus all the time, experimenting with improvements in materials and in methods, spending the greater portion of their leisure time at the work. They are the enthusiasts.

It was a New York amateur, Edwin Howard Armstrong, president of the Radio Club of America, who invented the regenerative action of the vacuum tube detector which has made possible many recent evolutions in the radio art. Mr. Armstrong is now a Captain in the Signal Corps, U. S. Army, and has been in France for over a year as radio expert.

Below is a list of a few New York radio AMATEURS who have been in the U. S. Government service since we declared war on Germany, stationed in Washington, helping to solve the many radio problems from their knowledge obtained through experimenting with their own home-made amateur apparatus:

Mr. T. Johnson, Jr., Expert Radio Aide in charge of Aircraft Radio, U. S. Navy.

Lieut. H. Sadenwater, U. S. Navy, Radio Officer, Aircraft Radio.

Lieut. W. S. Lemmon, U. S. Navy, Radio Officer, General Radio.

Mr. B. R. Cummings, Expert Radio Aide, General Radio, U. S. Navy.

Mr. F. W. L. Horle, Expert Radio Aide, General Radio, U. S. Navy.

Mr. T. A. Hart, Expert Radio Aide, General Radio, U. S. Navy.

Mr. A. Allen, Expert Radio Aide, General Radio, U. S. Navy.

Mr. L. Spangerberg, Radio Inspector, Aircraft Radio, U. S. Navy.

Mr. J. A. Fried, Chief Radio Draftsman, Radio Division, U. S. Navy.

Ensign T. J. Styles, U. S. Navy, Aircraft Radio.

Capt. D. C. McCoy, Radio Officer, Division of Military Aeronautics.

Mr. J. O. Smith, Radio Expert, Division of Military Aeronautics.

With restrictions under the existing law of 1912, and using modern apparatus of the continuous wave type, the radio amateur cannot cause interference with naval stations. In my estimation, instead of eliminating the amateur, he should be encouraged to experiment more than ever, so that if the emergency should again arise, the Government will have at its disposal many thousand radio stations needed on airplanes, tanks, balloons, warships, torpedo boats, troopships, land stations of any type, etc.

If this bill becomes a law, it means that the "radio amateur" will be completely ignored and only "scientists" will be allowed to experiment with radio apparatus of any description—receiving stations included. By a scientist, I mean a professor, or highly technical engineer, actually considered such by the Secretary of the Navy.

You are requested to take immediate action against the approval of this bill without an amendment authorizing the "radio amateur" to operate or maintain a radio station for experimental purposes.

LOUIS GERARD PACENT,
Radio Club of America.

Genuine Preparedness

THE lamentable unpreparedness of our country at the time of entering the war was complete in every respect but one—radio operators. The immediate response of some twenty-five odd thousand amateurs, trained to the minute in radio operation, was the one conspicuous exception to our otherwise total unreadiness. It seems unbelievable that the Government would countenance the loss of thousands of men in constant training for one of the most important branches of warfare, as would result by the passage of the Alexander bill in its present form.

Let the Amateur still be under the regulation of the Government as in the past, and this army of specialists will be ready day and night for the country's call.

H. E. RAWSON,
Station 7ZR, Rawson Ranches,
Kuna, Idaho.

Unjust Legislation

THERE is now pending before the House a Bill, H. R. 13159, proposed by Mr. Alexander to "Further Regulate Radio Communication."

I would strongly urge your opposition to the passage of this bill, as it aims to suppress the development of radio communication by private individuals.

Among the many reasons why the "radio amateur" should be encouraged rather than suppress, are the following:

Immediately after our entry into the war, FIVE THOUSAND RADIO AMATEURS placed themselves at the disposal of the Military and Civil Departments of the Government. This would have been entirely impossible were it not for the fact that, before the war, there were many thousands of radio amateurs experimenting and maintaining their own stations, built by themselves and used for developing the art. Moreover, the present high stage of development is largely due to the efforts of radio amateurs. Preeminently among these is Mr. Edwin H. Armstrong, who through the development of the oscillating audion made possible the practical use of long distance communication and the possibility of directing, by means of the radiotelephone, Aircraft in battle.

Many high positions are now held in the Military and Civil Governmental Departments by men who just recently were radio amateurs.

Any legislation which ignores the radio amateur is fundamentally unjust and should be relentlessly opposed.

A. H. Grebe.

QRM from Washington

THE eighth wonder of the world is the activity of Congressmen in and about a number of things that are useless, and in some cases, pernicious. One of the most startling examples of this proclivity has been manifested recently in the House of Representatives by the introduction of a bill in the 65th Congress by Representative Alexander for the ostensible purpose of regulating radio communication, which in reality is a bill calculated to wipe out the radio amateur in the United States and take away from the people at large all right to have wireless apparatus or to become proficient in the use and management of an amateur wireless station.

How serious such a prohibition would be to the interests of the country at large is revealed when we consider the part that the so-called "radio amateur" has played in the War for Freedom just closed. At the outbreak of the war the Government of the United States sent out a call for all the "trained radio operators" who would volunteer to serve the Government during the period of the emergency. More than 5,000 patriotic Americans, who had acquired skill in the operation of radio through the amateur wireless stations which they conducted, responded and made themselves available for the uses of the Army and Navy. Without amateur radio operators, the Government would have been obliged to take raw recruits, unfamiliar with wireless, and given them months of intensive training before the required personnel could have been added to the Signal Corps for wartime uses.

How important this was will be appreciated when we recall that a great modern General said, "The difference between good and bad communication on the battle line is the difference between life and death." The worst part of the introduction of this bill is that it is not the first time that Congress has felt called upon to attempt legislation against the radio amateur. In 1912 a bill was introduced in the House, somewhat similar in its provisions to the present one, which also contained no permission for "radio amateurs" to operate.

A wave of indignation swept the country at that time from the Atlantic to the Pacific, and so strong a protest was made that the bill was defeated; and a lucky thing for Uncle Sam it was, too, as otherwise there would have been no operators upon whom he could call to do the most urgent work of the war, except the mere handful of paid commercial operators. Now that Congress has been busy for the past year and a half taking over control of private enterprises on behalf of the Government, it undoubtedly feels that the time is ripe to take away from the people the privilege of using and maintaining wireless stations, and the bill is submitted once more to Congress with the hope of passing it under the cloak of an "emergency measure" which no one will have the courage to assail at a time like this.

The American people are fully awake and alive to the situation, however, and every organization, firm, magazine, and man in this country with the interest of amateur radio work at heart has taken up the gage of battle against a bill designed to deprive our country of its only source of supply of radio men in time of trouble. Everyone who has had any experience in radio work has had experiences with young men who have taken up wireless as an amusement at first, and who have afterward developed into first class radio operators and experts. The writer, in his long experience in conducting an amateur radio station has had opportunity to observe countless young men starting out in the amateur field, and has watched them grow into A1 technical men, better equipped even than the professionals, by reason of the fact that general amateurs by Governmental regulation must contend with the difficulty of operation with wave lengths of not over 200 meters. In addition, most of them use home-made apparatus, which is of great aid to them in teaching them the construction and design of apparatus for wireless use.

Short waves were almost universally used in the war for trench work, and by reason of the fact that amateurs had, by the Government restriction, been obliged to work on those wave lengths, they attained a skill which the Government experts had previously thought impossible. This was wholly due to the fact that the amateur had been forced to experiment with a spark transmitter tuned to 200 meters, until he was able to transmit and receive with any degree of accuracy, since the year 1912.

A similar bill to the Alexander Bill (H. R. No. 13159) has been introduced in the United States Senate (S. No. 5036) by Senator Fletcher in conjunction with the bill in the Lower House. Both of these bills must be killed if the radio amateur is to live. Whether it is worth while keeping the radio amateur alive is amply demonstrated by his use in the great war.

Congress should be made to understand that amateur stations are not cheap toys. I have personal acquaintance with at least fifty amateur equipments that are on a par with coastal stations in point of efficiency. My own station, 2 PM, cost about $500 in cash and a great deal of labor to construct. It could not be duplicated for $1,500. There are many other amateur plants of equal value.

Man to man, is it right for any Congressman or Senator to attempt by legislation to stifle the spirit of inventiveness and ingenuity in this line of work, especially in view of the noble and patriotic service just recently rendered to the country by the, now, despised amateur? It is not to the interest of the people in the perpetuation of republican institutions, to allow such laws to be passed!

John F. Grinan,
Owner of Radio Station 2 PM.

Experimenters' World

Langmuir's Circuit and Apparatus for Operation of the Vacuum Tube

A PATENT recently granted to Dr. Irving Langmuir of the General Electric Company shows a vacuum tube of unusual construction connected in a receiving set circuit for the detection of electrical oscillations.

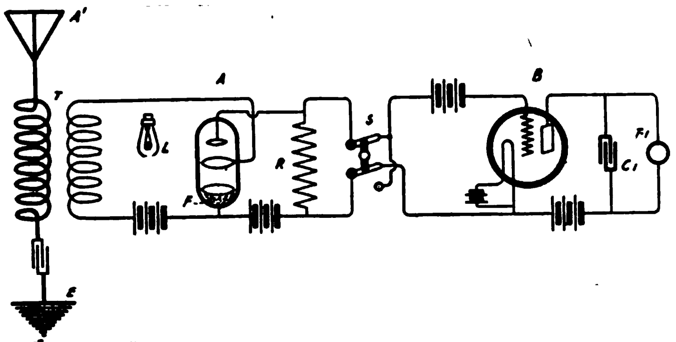


Figure 1—Langmuir's circuit and apparatus for amplifying variable currents

Figure 1 indicates a cascade system where the plate or output circuit of tube A is coupled to the grid or input circuit of tube B, through a resistance R. This usually has a value of 20,000 ohms.

The filament F is not heated by a battery as in the usual tube but it consists of potassium, sodium or other metal which emits electrons when illuminated by the source L.

A monochromatic source of light such as a mercury vapor arc in a quartz or glass envelope has been found to give off electrons of uniform velocity. The anode or plate preferably consists of tungsten and the bulb is exhausted of gas by electron bombardment during the exhausting process. The pressure in the envelope is reduced to a value at which no appreciable gas ionization can occur.

A two-way switch S is provided between the plate and grid circuit of figure 1 and when it is placed so as to connect the positive terminal of the resistance R to the grid circuit of the second tube, which contains a battery for making the grid negative, an increase of plate current in the circuit of the tube A will produce an increase in the plate current of the circuit of the tube B. When the connections are reversed the converse is the case. As in the usual receiving circuit the receiving transformer with its primary and secondary windings is indicated at A, the aerial at A′ and the earth connection E. The current translator is the telephone T-1, which is connected in the plate circuit and shunted by the variable condenser C-1.

The apparatus shown in figure 2 is the usual cascade radio frequency amplifier—a circuit applicable to the reception of damped oscillations. Through the tubes A and B, the incoming radio frequency currents are progressively amplified, the transformers T-1, T-2 and T-3 being air core radio frequency transformers of the necessary dimensions for tuning to an incoming signal. The secondary of the three transformers are shunted by variable condensers as usual. It is to be noted that the vacuum tube C

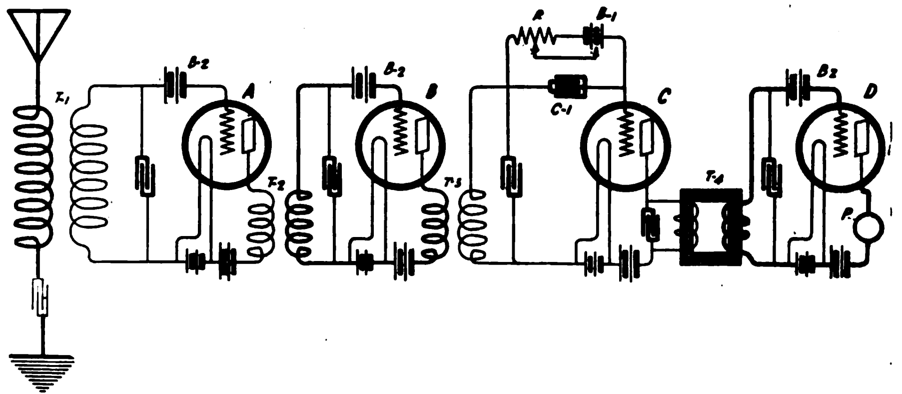


Figure 2—Usual cascade radio frequency amplifier

includes in its grid circuit a series grid condenser C-1 which is shunted by the battery B-1 and the resistance R connected in series. The object of the condenser C-1 is to secure an integral effect of each group of incoming oscillations so that the effect in the plate circuit of the vacuum tube B is to produce an audio frequency pulse of current—one pulse for each spark at the transmitter.

The operation of this part of the circuit is well understood by the field at large, the amplified incoming radio frequency currents being rectified, accumulating a change in the condenser C-1 over the duration of a wave train which makes the grid increasingly negative, reducing the plate current. At the termination of the wave train the charge leaks out, the condenser C-1 being assisted in discharging by the battery B-1. Thus the grid potential of the valve is restored to normal value between each group of oscillations and consequently the maximum effect is obtained in the plate circuit.

Tuning to audio frequency or, in other words, to the spark frequency of the transmitter is accomplished through the transformer T-4, which contains an iron core and is of the necessary dimensions to be resonant to frequencies around a thousand per second. The secondary terminals of T-4 are connected to the grid circuit of the tube D, the plate circuit of which contains the telephone transmitter P.

Both tubes have a source of grid potential—the special grid battery B-2—the object of which is to adjust the potential of the grid in respect to the filament to a slightly negative value, for this has been found to give the best signals.

The effect of the series condenser in the grid circuit of the tube C in figure 2 is shown by the graph in figure 3 where the successive cycles indicate how the potential of the grid to filament varies during the passage of a group of radio frequency cur-

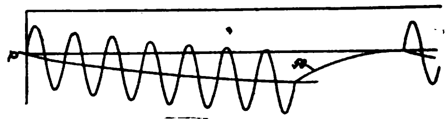


Figure 3—Graph showing how the potential of grid to filament varies

rents. It will be noticed that the effect of the first half cycle is to make the grid slightly positive but as rectification occurs and a charge piles up in the grid condenser C-1, the grid

(*Continued on page* 34)

Vreeland's Selective Wireless Telegraph System

FREDERICK VREELAND believes he has solved the problem of selective and secretive wireless signaling by use of the apparatus shown in figures 1 and 2. The fundamental circuits admittedly are simple, the only unexplained device being the recording instrument to take down the signals. As a novelty of this system it is to be noted that in figure 1 a mercury vapor arc is employed to generate radio frequency currents, and at the receiver a small mercury arc generator is employed for similar purposes to form beat currents, the only thing of importance missing being the recording device, which the inventor remarks may be a telephone, a vibration galvanometer or a mechanically tuned relay. If the reader understands the working of the well-known beat receiver, little attention need be paid to the diagram.

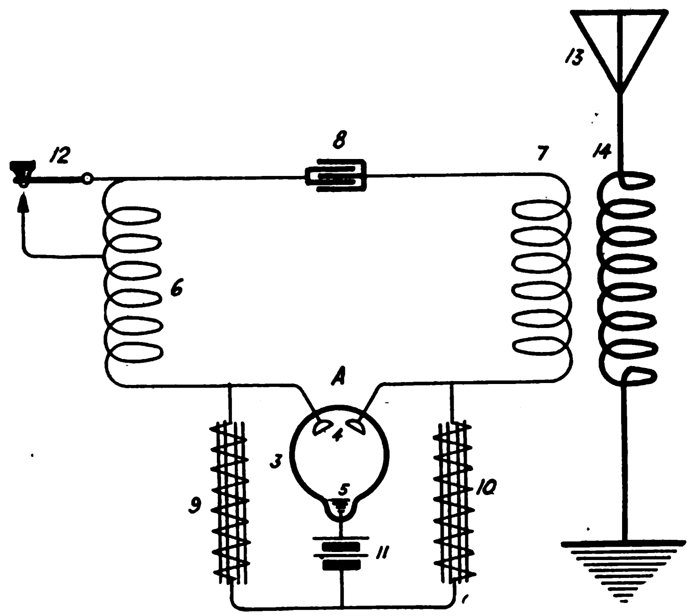


Figure 1—Circuit employing mercury vapor arc to generate radio frequency currents

As a fundamental working basis of the apparatus it may be said that when a local radio frequency generator at a receiving station is adjusted to the correct frequency for the production of audible beats, the difference in frequency between the local generator and that of the incoming signal is practically insufficient, in the inventor's opinion, to require separate tuning for the two currents. It is also evident that in a receiving system of this kind, adjusted for beats, the slightest change in frequency at the transmitter will produce a corresponding change in the beat note. This, in fact, is one method by which the inventor accomplishes radiotelegraphic signaling. For example, if the receiving apparatus in figure 2 is adjusted so that the frequency of the local generator is slightly different from that of the incoming signal, a continuous beat note will result in a telephone provided the transmitter is in constant operation. If then the transmitting operator presses the key 12 in figure 1, the slight detuning of the transmitting circuit occasioned thereby will cause a sufficient change in frequency to either increase or decrease the pitch of the beat current at the receiver. The operator will then translate the signal heard when the transmitting key is pressed and he may select as a normal pitch for the continuous note at the receiver, any frequency that will make clear the superimposed note.

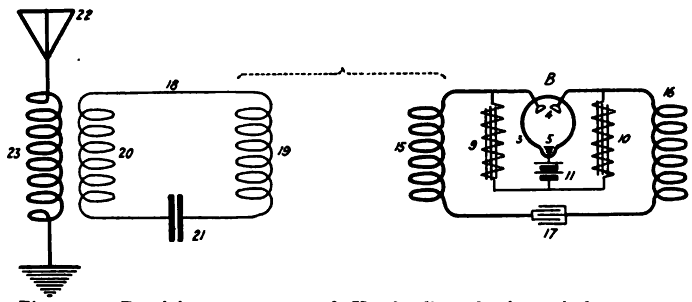


Figure 2—Receiving apparatus of Vreeland's selective wireless system

Assume again that the frequency of the local generator at the receiver is the same as that of the transmitter: No beat note will result but when the transmitting operator presses the key 12 detuning the transmitting circuit an audible note occurs in the receiver. A vibration galvanometer or a relay or other mechanically tuned receiving device may be adjusted to record the beats. Again the recording device may be such as gives no indication from the audio beat but responds to the intervals of silence in this case. It is evident that unless a spying station was provided with a similar receiver it would be unable to record the signals.

It is obvious that the beats need not be of an audible frequency, provided a receiver is employed capable of discriminating between the beat frequencies corresponding to the signal and no-signal conditions, such as a vibration galvanometer or relay, in which case the signals may be visually displayed or be recorded or both.

A numerical example will illustrate the very small change of frequency required at the transmitter to produce readily distinguishable audible tones. Suppose the frequency of the sending oscillator be 100,000 cycles per second and that of the receiving oscillator be 99,500 cycles per second, or one-half per cent less. Then the beat frequency will be 100,000 — 99,500 = 500 beats (cycles) per second, a rather high pitched musical note. If now the sender frequency be changed to 100,050 cycles per second (one-twentieth per cent higher) the beat frequency will become 550 cycles per second, a change of 10%, or nearly a whole tone of the musical scale, a marked interval easily observed. If the sender frequency be 100,000 and the receiver frequency be 99,900 (one-tenth per cent below sender) the beat frequency will be 100 (cycles) per second (a fairly low note) and a difference of only 10 oscillations or 1 in 10,000 will produce a 10% change in the beat frequency. A minute change in the sender frequency will therefore produce a relatively large change in the beat frequency.

LANGMUIR'S CIRCUIT AND APPARATUS FOR OPERATION OF THE VACUUM TUBE

(*Continued from page* 33)

becomes increasingly negative; at the termination of the wave train the grid potential returns to its normal value as indicated at P.

A feature of the cascade amplifier is, that by tuning successive circuits, the undesired oscillations are reduced in each case in geometric proportion. The additional selectivity occasioned by the use of the group frequency tuner, reduces the problem of interference to a minimum.

Construction and Operation of the Field Telephone and Buzzer

IN a previous article, I informed your readers of certain ideas which I developed in connection with field signaling work applicable to junior military organizations. In this article I present data for the construction and operation of a portable field telephone and buzzer set.

The portable station consists of the instrument case and carrying case. The carrying case has a compartment to hold two No. 6 dry cell batteries, which supply the power to the portable set.

The instrument case is made from the following pieces of kiln dried ¼-inch wood, preferably hard:

2 pieces 4¼" x 3" top and bottom
2 pieces 4 " x 3" sides
1 piece 3¾" x 3" front
1 piece 3½" x 3" back

Before assembling the case, mount the triple pole double throw switch on one of the sides, using two binding posts on the two arms to which the telephones are connected. The binding posts are used in place of the screws which hold the switch arm to the side. Connecting in this manner does away with complicated inside wiring. Fasten the buzzer to the base of the case, mount the strap key and two binding posts to the inside of the front so that, when the cover is opened, the key will be on the inside. The general assembly is shown in figure 1.

Mounting of the Transmitter

The transmitter, as I stated in the first installment, should work on three volts, and be of very light weight. The Crown Telephone Company make the best transmitter that I know of. It is light in weight and works remarkably well on three volts.

As to the mounting of the transmitter there are several satisfactory methods. The first is to make an arm which is fastened to the back of the receiver, and has the transmitter mounted on the other end. The second method is to employ the mounting used for switchboard operators. I am unable here to give the exact dimensions for either method, as it depends upon the size and style of transmitter to be used. Probably the best style is the one used by telephone repairmen throughout the country.

It is my advice that the builder go to the telephone company in his city or town and obtain actual measurements of the style of apparatus he has decided to use. By so doing he will save a great amount of time and trouble. There are so many styles and types of receivers and transmitters that it is useless to consider any one type here. I might take a certain type as standard, which could not be obtained; therefore, I have left the matter for the judgment of the maker.

Operation of the Portable Set

If the two sets after completion are not to be used through an exchange, or the exchange is not completed, be sure that the polarity of the battery of one set is reversed, in respect to the other set, for it is impossible to operate otherwise.

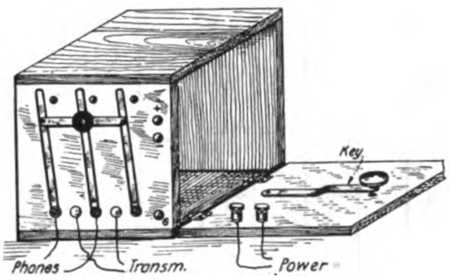


Figure 1—Portable station assembled and ready for use

In the portable set a small one-point switch must be employed so that the arm of the switch connected to the side of the batteries goes to the lower contact of the key, the other side to the line side of the circuit.

When the switch is closed the call light on the exchange will light up, notifying the operator that you wish to communicate with another station.

After finishing transmission, close the switch for at least five seconds. During that time the exchange operator will withdraw the plug connections.

Before calling a station—either the exchange or another portable set—have the T.P.D.T. switch on the buzzer side. Always have the switch on this side for calling, making sure to change back again after using the telephone circuit.

A copper rod 6 inches long must be carried with each portable set. This rod is connected by a wire and driven into the ground. The wire is connected to the ground side of the buzzer.

The following list of "Do Nots" if adhered to will save a lot of time and trouble:

DO NOT call the exchange by means of the telephone.

DO NOT leave the T.P.D.T. switch on the telephone circuit after using this means of communication.

DO NOT forget to see that the lines and batteries are connected up according to the diagrams.

DO NOT forget to notify the switchboard when you have finished transmitting your message.

DO NOT send anything unnecessary, as there may be important business for your commanding officer from headquarters.

DO NOT forget to make ground connections.

DO NOT fail to notify your repairman if the set fails to work.

Wiring of Switchboard

The switchboard described in this article has a capacity of six stations; four line and two headquarters, or company and battalion.

A switchboard to be used for military organizations must have these requirements:
(a) Simplicity.
(b) Ability to send from one headquarters to all line stations.
(c) Calling and finish lights.

The switchboard in figure 2 has 17 binding posts, used as follows:

No. 1 through 12—To which the lines are connected.
No. 44 and 45—For power connections.
No. 46 and 47—For the telephones.
No. 47—Ground wire connections.
Six three-volt bulbs, Nos. 38 through 43.
Twelve plug receptacles for receiving the plugs Nos. 13 through 24.
Thirteen plugs, Nos. 25 through 36 and B.P.X. (Switchboard plug).

The reason for connecting together two plugs and two receptacles and one lamp follows:

If a station desires to communicate with another station, there must be some means of connecting them together. By connecting the plugs and receptacles of each set together, that is, when the plugs of one set are pushed into the receptacles of another set, a complete circuit is made.

In the set a buzzer and key are placed so that when the lights show that a station is calling, the exchange will have a means of answering and calling.

Construction of the Switchboard

The switchboard shown in detail in figure 3 is made of wood which is ¼" thick.

The following pieces must be cut accurately if a neat switchboard is desired:

2 pieces 7½" x 13½"—sides, cut as per figure 3
2 pieces 6 " x 6 "—upper front & back (A & B)
1 piece 7½" x 6 "—lower front (C)
1 piece 7½" x 6 "—lower back (D)
1 piece 8 " x 6 "—bottom (E)
1 piece 5 " x 6 "—plug board (F)
1 piece 1½" x 6 "—back mount (G)
1 piece 1½" x 6 "—top (H)

The pieces were designed so that the back is entirely removable in order that the wiring may be done in a neat manner and yet permit free access to all parts.

Take the two sides and mount front C on them, then set on bottom E and fasten with screws. Take the back mount G and mark off 10 holes as shown in figure 3, part A, and drill with a 1/8" drill; then mount 10 binding posts with a base diameter not to exceed 1/4". Slightly smaller posts would perhaps be preferable. Next put on the top H.

On the upper front A mark off and drill as per figure 3, part B. Cut twelve strips of copper 1/4" wide and 1½" long. Bend each strip ½" from one of the ends; mount one over each hole as shown in figure 3, part C.

After drilling all holes, including those for the lamps, (the size of these holes depends upon the size and style of bulb), and the copper strips are in place, mount the board and proceed with the wiring. From each set of contact arms run two wires, one to each arm to the lamp corresponding to the contact arms above as per the wiring diagram figure 2. There are ten binding posts, 1 through 10 starting at the right when the back is toward you. Numbers 2, 4, 6, 8 and 10 are marked (+) and the others (—). The even numbers are connected to the upper row of receptacles No. 2 to No. 13, etc. The uneven numbers are connected to the lower row No. 1 to No. 14, etc.

Take five pieces of flexible wire each 14½" long and fasten one end of each to binding posts Nos. 1, 3, 5, 7 and 9.

Take five pieces of the same wire each 17" long and fasten one to each of the remaining posts.

Drill the plug board (F) as shown in figure 3 and mount as shown. Drill the short leads through the holes nearest the front A. Pull the longer leads through the remaining holes.

Cut two wires, one 14½" and the other 17" long, and connect to the two headquarters binding posts on the side. Also connect plug receptacle No. 23 to post No. 12 and No. 24 to No. 11, being sure to connect the lights at the same time. Pull the two leads through the remaining holes.

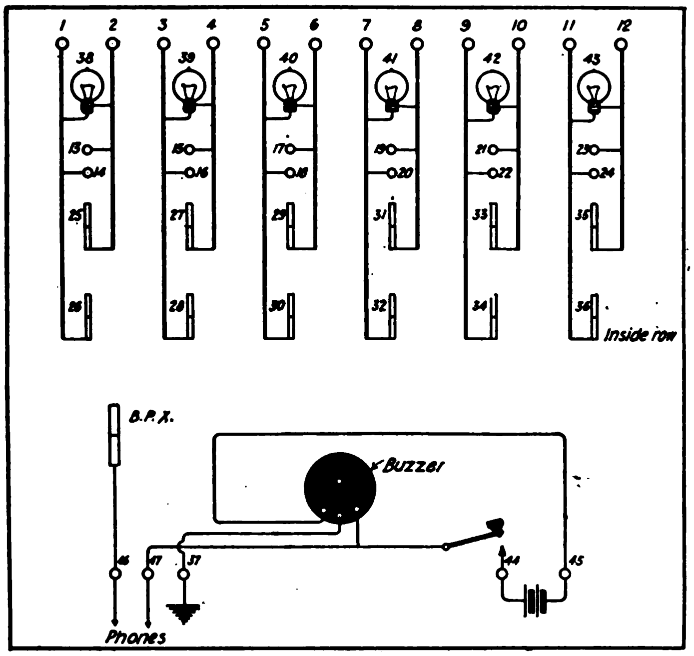


Figure 2—Showing wiring for switchboard

Make thirteen weights of lead each 1" square and drill a hole through the center. Fasten one to each of the leads, on the short leads 5" from the end joined to the binding posts, and on the long leads 6" away. These weights will be heavy enough to hold the wires in place when not in use, and are heavy enough to cause the wires to return to their original position, when released from the plug receptacle. Connect regular telephone plugs on the end of the wires coming through the mount and make the final adjustment on the weights. I offer the following suggestions: Use six black and six red plugs, the inside row of plugs black and the outside row red, the exchange plug red also. Paint a small red ring around the upper row of plug receptacles and black on the lower ones. By doing this, many a mistake will be avoided. Mount a buzzer inside the case and connect to the binding posts marked on figures 2 and 3. Cut a flexible wire 17" long and connect one end to the binding post No. 46, pull the other end through the hole provided for it, fasten a plug and a lead weight. Make the adjustment so that the plug will fit into any one of the plug receptacles. Then mount key and finish the remainder of the assembly.

Testing

After the switchboard is connected it must be tested, not with a portable station, but with a quicker method. Take two dry cells and connect together. Connect the two wires to binding posts No. 1 and No. 2. If properly wired, the light No. 38 should burn. Push plugs 25 and 26 into the plug receptacles of each set and if the lights burn they are correctly connected.

The next step is to see that all the plugs and plug receptacles are connected properly. Take the two batteries and connect one side to binding post No. 1. The other side to one side of a bell, and from the other side of the bell a long wire is attached so that it can be connected to Nos. 3, 5, 7, 9 and 11 in rotation. Connect to No. 3, and push plug 26 into receptacle 16; if the bells ring the circuit to this point is correct. Change the bell wire to No. 5 and plug 26 to 18. Do this to Nos. 7, 9 and 11, being sure to use plug 26 in all cases. If the bell rings each time you change the wire and push the plug into the corresponding receptacle, the circuit is O.K. If it does not ring immediately change the wires of the binding posts. It will then ring. By making these simple tests you will know whether you have done your work properly.

Operation of the Switchboard

When the switchboard and stations are ready for use, connect the lines from the portable station to their respective binding posts on the switchboard. Be sure to have the line side from the portable set connecting to the (+) binding post on the switchboard, the other wire connected to the (—) side.

When the call switch at the portable station is closed, the light across the two binding posts to which that station is connected will burn. Push the exchange plug into the upper row (+) of the receptacles into the one corresponding to the station calling. Send RK, which means "All right, go ahead." The station calling will then send the call letter of the station wanted, which is acknowledged by repeating the call letter or letters once. Now push the plug or plugs of the station calling into the plug receptacle (s) wanted and press the key once. This is to notify the other station he is wanted; then remove your plug. When I say plugs, I mean this: when the buzzer is to be used you only need one plug. On the wiring diagram of the switchboard they are the plugs with the uneven numbers, No. 25, etc.

When the telephone is to be used, the calling station will signify by sending the call letter of the station wanted twice, followed by the letter T twice.

Push the + plug into the — receptacle and the — plug into the + receptacle of the station wanted.

The reason for crossing the lines is that all stations are wired up in the same way, all plug sides of the batteries on each set being joined to the same instruments. When the buzzer is in use it makes no difference whether the power is the same or not. With the telephone the batteries must be in series. That is, the positive side of the batteries on one set must be connected to the negative side of the batteries on the other set. That is why two leads are used, and why they are reversed when the telephone is used.

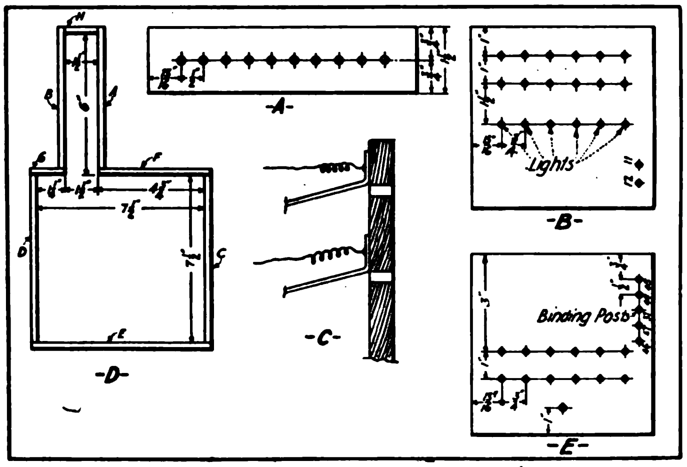


Figure 3—Plan of construction for switchboard

If headquarters wishes to communicate with one station, the preceding methods are true, but when a communication is desired with all stations at the same time, it is changed to this extent:

If the buzzer is to be used push plug No. 35 (which is one of the two regimental plugs) into plug receptacle No. 21, plug No. 33 into No. 19, No. 31 into No. 17, No. 29 into No. 15, No. 27 into No. 13 and plug 25 will remain. There is one left over because the receptacles and plugs of each set are connected together. Connected in this manner all stations are in series. Send a long dash followed by R.

When using the telephone both plugs must be used. Plug 35 into 22, 36 into 21. Proceed in the same manner as in the buzzer, being sure to reverse the plugs. Hold down your key for at least five seconds, then send RT, which will tell the operators that headquarters is about to transmit by means of the telephones.

The preceding feature is of great use and I am safe to say, original, in allowing direct or selective communication from the commanding officer and all officers of the line.

HEADQUARTERS STATION

The headquarters station may be of two different styles: either a portable set, or a switchboard of the type used by the exchanges. An exchange is the proper thing to install, if possible, for the advantages are obvious.

When an exchange is used at headquarters, three portable sets are employed, each set connecting with one set of binding posts. The other three sets have the lines from the exchange connected to them. The following shows the number of intercommunications possible:

1—Transmission to one or all stations of one company.
2—To one or all of two companies.
3—To one or all of three companies.
4—Working three different stations at the same time.

WHO PAYS FOR THE APPARATUS

Each company or battery will furnish a portable set, to be kept by that company. They will also have two men trained as operators.

The companies making up a battalion will each contribute an equal amount of money for the cost of constructing an exchange. The Signal Corps will furnish the operators.

All companies will bear the expense of equipping headquarters with a portable set or exchange, to be kept by the Signal Corps. All operators for headquarters to be drawn from the Signal Corps.

The wire to connect up the apparatus will be furnished in the same way, excepting that the Signal Corps will supply the wire to go from each exchange to headquarters.

INSTRUCTIONS FOR OFFICERS

1—An instruction school to be conducted by the Signal Corps in operation, maintenance, and construction of the apparatus.
2—Have three trained men who are to be expert repairmen and "trouble shooters," trained on both the portable set and switchboard.
3—Hold an examination for appointment to the grade of Master Signal Electrician. If you already have one, detail this sergeant to study this apparatus.
4—Each man should become a specialist, either as an operator, lineman or repairman.
5—Buzzer practice should be continued until every operator is able to copy at least fifteen words per minute.

If this advice is followed a great deal of unnecessary trouble will be avoided and a "crack" Signal Corps will be the result.

LIEUT. R. D. GREENMAN, U.B.B.A.

Multi-plate Spark Dischargers for Quenching Effects

A QUENCHING spark gap designed by E. J. Simon is shown in the accompanying figures 1 and 2, where two discharge gaps are in series to form the unit of a complete gap.

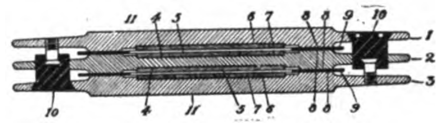


Figure 1—The Simon quenching spark gap

Figure 2 is a plan of a single plate showing the recesses 10 for the insulating bushing.

In figure 1 the intermediate plate 2 is provided with a seat or recess 4 of circular outline. The sparking plate 5 is preferably of electrolytic copper secured to the face of the plate 2. Copper plates 1 and 3 are constructed as plate 2 except that they are grooved

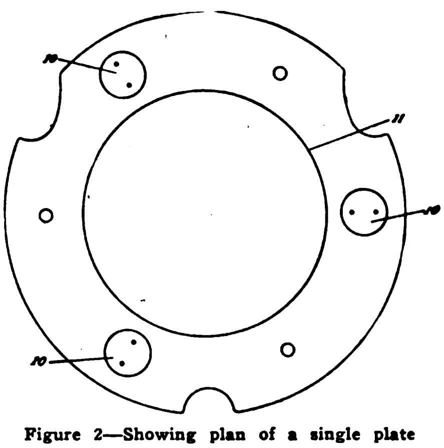


Figure 2—Showing plan of a single plate

on one side only. An insulating gasket 9 is interposed between the plate and it is made of special material such as will insure an air-tight joint.

At the points where the circumference of the plate makes contact with the insulating gaskets a series of circular grooves are cut in order to insure air-tightness.

The plates are tightly clamped together by the insulating bushings 10, which are drawn up by a small machine screw.

Contest for the January 1919 Issue Wireless Age

In response to the call in the November issue for manuscripts concerning the prevention of interference in amateur radio communication, prizes have been awarded to the writers of the following contributions. The subject upon which the contest was based was: "WHAT IN YOUR OPINION IS THE BEST METHOD TO PURSUE TO PREVENT UNNECESSARY INTERFERENCE IN THE EVERY-DAY USE OF WIRELESS TELEGRAPH APPARATUS?"

First Prize—Some Technical Aspects of Wireless Interference

IT is clear that if all amateur transmitting stations are to operate on the same wave length, and moreover they have been adjusted so that the radiated wave complies with the U. S. laws, a certain amount of interference is bound to result.

It would, therefore, seem highly desirable that the range of wave lengths allotted to amateurs be increased to, say, 300 meters, in order that different wave lengths may be designated to various localities. Committees selected by amateurs throughout the United States should designate the range of wave lengths to be employed in various districts, and these should be adhered to. If the use of such wave lengths is enforced, a great amount of interference heretofore experienced will be prevented, irrespective of the type of apparatus in use.

It is quite probable that vacuum tube transmitters and receivers will play an important part in future operations of the amateur, for the reason that they can be employed for the generation of continuous oscillations at wave lengths as low as 200 meters. Then by the employment of the heterodyne receiver a remarkable degree of selectivity will be secured, owing to the beat phenomenon itself. Whether or not the vacuum tube transmitter will be supplied to the amateur field at a price within the range of its financial resources is at this writing problematical, but it is certain that the only part of the vacuum tube transmitter that the experimenter will actually need to purchase will be the bulb, for all other apparatus connected therewith can readily be constructed by any experimenter handy with tools.

In order that the wireless experimenter may derive the benefits to be expected from the use of such apparatus a campaign of education regarding its use must be inaugurated. We will rely upon The Wireless Age to do this, but once the operation of the vacuum tube is understood, the amateur with most elementary knowledge will be able to adjust such a vacuum tube set for its maximum efficiency.

Even in the use of damped wave transmitters, increased selectivity can be obtained by employing a regenerative vacuum tube circuit. Any experimenter who has employed this apparatus has immediately observed that the use of regenerative coupling increases the factor of selectivity because it has the effect of reducing the total damping of the receiving circuits.

Many experimenters have not obtained good results from the regenerative amplifier because they have not been given proper constructional details, but I am sure that loads of amateurs—readers of The Wireless Age—have designed good circuits and will be glad to inform others through the columns of this department concerning the details of their design.

Experimenters have observed that the vacuum tube oscillation detector itself increases the factor of selectivity. This is accounted for by the fact that if the grid of the tube is held at a negative potential, the tube does not absorb energy from the oscillation circuits. The damping is therefore reduced and the sharpness of tuning accordingly increases.

For short distance amateur communication, that is, between stations within the same city, there is not a particle of doubt that the buzzer transmitters which have been so effectively employed in government communication will be adopted by the radio experimenter. This transmitter is of simple construction and inexpensive.

Regarding the lawless amateur, the fellow who jams the atmosphere promiscuously without regard to what is going on; he should be dealt with by police committees of local radio organizations. On top of this the government restrictions should be such that this type of experimenter will not be permitted to operate his equipment until he passes a fairly rigid technical examination and is able to receive and transmit in the International telegraph code at speeds between 15 to 20 words per minute.

I am very optimistic regarding the future of the wireless amateur. I believe that the new inventions brought out during the war will aid him in every way and make his work more interesting, as compared with the types of apparatus used in the pre-war period. Constructional details of sets incorporating the results of recent research will undoubtedly be presented to the field at the proper time.

A. J. Holborn, *New York.*

* * *

Second Prize—Interference

IN discussing this subject it would perhaps be well to first apply a bit of analysis. Interference is an effect and there is necessarily a cause to

every effect. We must therefore investigate the various causes of interference before we can prescribe a remedy. Briefly stated, all interference may be placed under one or another of two general classifications: Static, arc lights, trolley cars, etc., may be placed under one head; and as these offenders are purely physical, they follow certain well defined laws of nature which can be accurately determined by careful study, and eventually a scientific means of nullifying their effects will be evolved.

The offenders who come under the other head are beings who follow undefined laws of human nature; they can never be controlled by any physical means but must be handled by moral suasion

For the offenders in the first class various remedies have been applied from time to time by many of the foremost authorities on radio, with some success. This topic is one of the chief subjects of research by all investigators, and the fellow who is actually successful in discovering a perfect cure for "static" will win fame and fortune immediately.

The following suggestions bear solely on the control of interference from offenders of the second class:

In reviewing operating conditions in the amateur field up to the time the stations were closed, certain facts become evident. Before the sinking of the Titanic, when the amateurs were free and unrestrained, you could listen in any evening to as fine an imitation of a jazz band as one could desire. No matter where you paused in your tuning, amateur stations with most every known and unknown tone and volume of spark could be heard asking each other "how they came in"—this was ever the chief topic of conversation. When the restrictive radio laws were put into effect, it was thought the death knell of amateur radio had been sounded, as very few supposed any distance could be covered with such small power inputs. However, on the contrary, it proved to be beneficial instead of disastrous in its effects. It took the joy out of life for many triflers and they dropped out of the game. It taught the amateur the value of efficiency, however, as this was the only path left open for increasing his range. It also furnished incentive for serious attempts to advance his work, as it gained him public recognition. And last, but not least, it taught a lesson in respecting the rights of others. All this is established fact and is ample proof of what can be accomplished by proper legislation when justly enforced.

Now let us consider what resulted from this incentive for betterment among amateurs:

The theory of radio was more seriously investigated and applied in the construction and operation of his instruments, and manufacturers had to supply better and more efficient apparatus to suit his requirements. With this better equipment came a natural desire to use it to better advantage, and the standards of operating were raised. At this point the possibility of extending operations into adjoining states was seriously considered, and it was soon realized that in order to accomplish this some definite system would have to be adopted that would enable the efforts of the various individual stations to be brought into harmony, prevent misunderstandings and allow all to pull in one direction. This led to organization of a body of serious minded amateurs, and lines of communication were established throughout the country over which messages were routed. The results obtained exceeded the fondest hopes of the past, and amateur radio was given a new lease of life. All this is likewise established fact and proves what organization can accomplish.

Retrospect is always pleasant, but in this I have an object, and that is to remind you by way of example, of the power *proper legislation and organization* can exert in the amateur field to accomplish a purpose. It is by these means that I believe the evil of unnecessary interference can be eventually cured. It cannot be hoped to make much headway in this direction by the scattered efforts of a few individuals or small groups. The problem is such that it will require the concentrated labor of practically all the amateurs, united in the common cause and working in harmony in a persistent effort to solve it. It is suggested that after stations are opened, the N. W. A. and other bodies representing the interests of amateur radio, co-operate in a nation-wide movement to eliminate unnecessary interference. A joint conference should be held for the discussion of ways and means. Some definite plan should be agreed upon, such as arranging a time schedule and rules of operation that will give every one a chance, by dividing the twenty-four hours of each day into appropriate periods of time and allotting same to the various classes of radio traffic, the most advantageous periods for the most important work, etc. Then these official rules and regulations should be declared broadcast to all stations through every available channel. By adopting an appropriate slogan and pushing the campaign with enthusiasm, it is bound to reach all concerned with gratifying results. And legislation of the amateurs by the amateurs and for the amateurs is most likely to be respected by all.

J. A. WEVER, *Maryland.*

Third Prize—It Rests with the Amateur

I THOROUGHLY believe that the prevention of interference amongst amateur radio stations lies within control of amateurs themselves.

Technical considerations have been avoided in the following suggestions, for my long experience shows me that it is up to the amateurs to apply the "Golden Rule" to as great an extent as possible. There are enough publications devoted to the amateur to supply him with the necessary knowledge to build a transmitting and receiving set that will give a large factor of selectivity, and since it is perfectly obvious that when a number of transmitting stations operate at the same wave length, interference must result, the whole matter resolves itself back into my former suggestion, namely, we must apply the "Golden Rule." Consideration for our fellow worker above all else will solve the problem of interference, even though it may be argued that as long as we comply with the laws laid down for us we are entitled to have the free use of the air. It is only fair that we keep our hands off the transmitting key once in a while and just sit in and listen, giving the other fellow a chance. Messages of importance should always have preference over mere idle chatter.

Frequently, I have listened in and heard more than a dozen amateurs within a given vicinity, trying to use the air at once. It reminded me of a stock exchange where you find perhaps a hundred men yelling at the top of their lungs, something they wanted you to understand. Perhaps you have seen them waving their arms, dodging back and forth frantically with no real result, until silence was enforced.

Although I believe we must appeal largely to the good sense of the amateur to prevent interference, we must not forget the necessity of having our transmitters properly tuned, so as to emit a pure wave and get the maximum efficiency therefrom. It seems feasible to train an amateur in the operation of adjusting his apparatus to such an extent that he can pre-determine its efficiency without unnecessary and constant querying from his fellow worker, "how do you get me?"

My opinion, in brief, is that the first consideration is to have a transmitting and receiving apparatus adjusted for maximum efficiency, and second to have the amateur use his good sense—not to act as if he were the sole owner of the space surrounding him.

H. B. NORDSTROM, *Minnesota.*

Locking Device for a Variable Condenser

WHEN variable condensers are employed in wireless telegraph apparatus subjected to jar and strain such as the equipment installed on an airplane, it is essential that they be provided with a locking device that to vibration. Also during shipment it is desirable to have these plates locked in position to prevent the apparatus from damage due to rough handling. If there is but a slight separation between the movable plates and the fixed

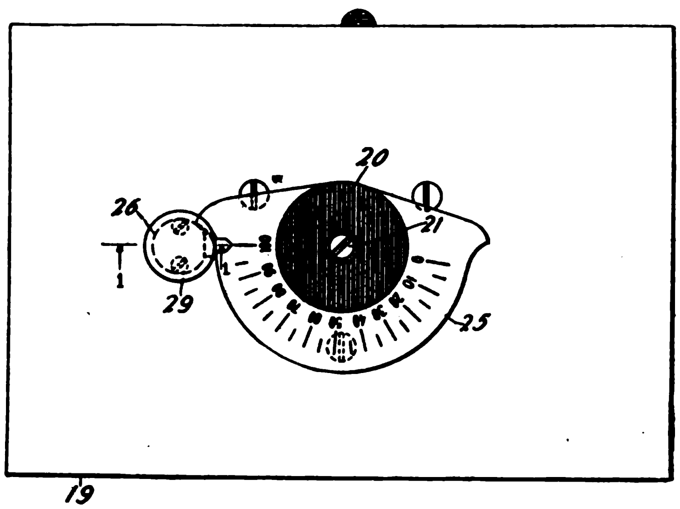


Figure 1—Plan view Gargan locking device

will prevent the movable plates from rotating without putting a severe strain on the condenser mechanism itself.

The movable plates of the average variable condenser are not balanced with respect to the rotating shaft and a tendency therefore exists for them to work out of position when subjected plates, it is highly desirable that the locking device employed be constructed so as to prevent any possibility of the strain changing the separation between the two sets of plates.

John Gargan of Brooklyn, New York, has recently shown a design for a variable condenser embodying this construction as shown in the accom-

panying figures 1, 2 and 3, figure 1 being a plan view, figure 2 a side elevation, and figure 3 a detail of the locking device.

ing jaws 27 and 28. The jaw 27 is assembled to lie in a plane below that of the indicating plate 25 and its inner end is provided with a threaded open-

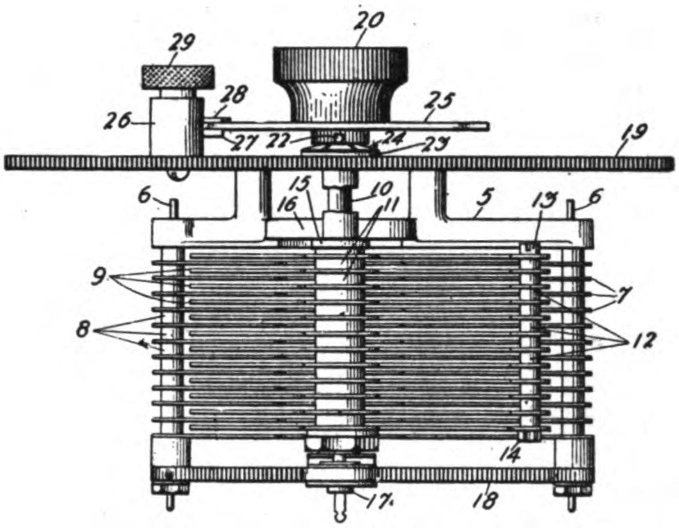


Figure 2—Side elevation Gargan locking device

In the detail of figure 3 the locking device comprises the clamps 27 and 28 which grips the plate 25 attached to

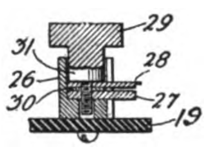


Figure 3—Showing a detail

the handle of the variable condenser. It consists of a hollow post 26 rigidly secured to the mounting plate 19 and provided with a longitudinal slot through which extends a pair of float-

ing adapted to engage corresponding threads in the knurled head screw 29. The inner end of jaw 28 is provided with an opening through which the threaded portion of screw 29 passes freely and its outer end is pointed to serve as a pointer for the indicating plate 25. Between the jaws 27 and 28 within the post 26 is located a washer 30 of a thickness somewhat less than that of the plate 25. Upon turning the screw 29, the shoulder portion 31 of the screw engages jaw 28, thereby clamping the indicating plate 25 firmly in position.

Coolidge's X-Ray Tubes

THE exhaustive researches of William D. Coolidge in the X-ray field are well known to readers of THE WIRELESS AGE. He has recently shown the design of two complicated structures as per the accompanying drawings figures 1 and 2.

The tube in figure 1 comprises an envelope consisting of an inclosure 1 of metal such as copper and an inclosure 2 of insulating material, preferably glass. A section of platinum 3 is welded or soldered to the copper wall at 4 and is sealed to the glass wall at 5. A copper tube 6 is welded or joined to the tube 1 at 4 and extends into the insulating part 2 of the envelope at the joint 5.

The cathode is a coiled filamentary conductor 7 consisting preferably of tungsten. In this diagram it is shown on edge. Surrounding the filament is tube 8 of molybdenum or other suitable conductive material which acts as a focusing device. One end of the cathode filament is joined to the focusing device and the other end to the conductor 9. Two wires 10 and 11 are joined to the tube 8. They are secured to a split tube 12 of molybdenum or iron. The wires 9, 10 and 11 are bound together by bridge 13, suitable insulation being used if the bridge consists of conducting material. The wires 9 and 10 are sealed into the closed end of the tube section 2. The cathode structure is carried by tube 14 of glass or a suitable insulating material.

An anode plate or target 15 is applied within the metal end 1. It consists of tungsten or other suitable refractory metal. The target is cooled by water, air or other suitable cooling fluid circulating through a chamber back of the anode into the wall of which are sealed tubes 16 and 17 for supplying and withdrawing the cooling fluid. Opposite the anode is a tube 18 closed with a window 19 of thin metal, glass or other material relatively transparent to X-rays.

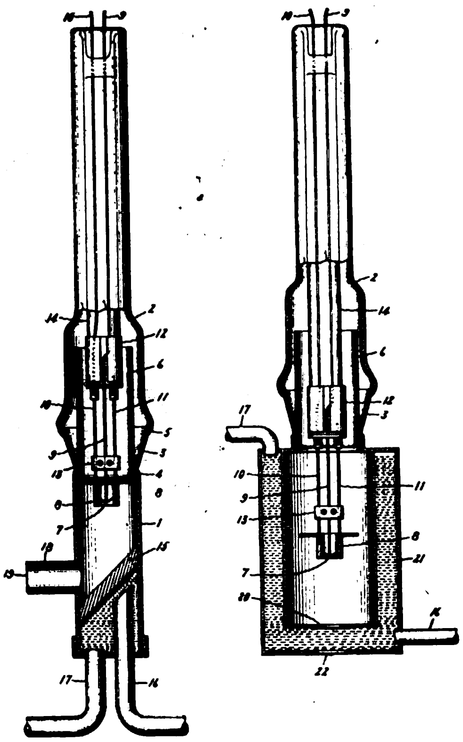
The tube is exhausted of gas to a pressure so low that the conduction of electricity can occur between the cathode and anode across the vacuous space independent of positive gas ionization.

During the exhausting process, traces of oxids which are apt to give off gas during the operation of the tube may be removed by introducing

hydrogen gas, heating the walls of the tube externally and then re-exhausting to the required low pressure, say, below .05 of a micron of mercury pressure.

To place the tube in operation the cathode 7 is heated to incandescence by passage of current and a source of current of suitable voltage is connected at its negative terminal to the cathode and at its positive terminal to the anode housing 1 with which the target plate 15 is in electrical contact. The electrons emitted by the cathode travel under the influence of the electrical field to the anode where X-rays are produced by their impact. The cathode rays are focused by the electrostatic field of the ring 8 to strike a spot of limited area on the target. Some of the X-rays are permitted to leave the tube through the window 19 so as to be available for use.

The tube shown in figure 2 is similar to that in figure 1 with the exception of the anode construction. The cathode rays strike an anode plate 20 consisting of thin metal such as platinum or silver where X-rays are generated which pass through the cooling fluid contained in an outer housing 21 and out through a window 22 which may consist of thin metal, for example, aluminum. If the plates 20 and 21 are made very thin, some of the cathode rays will pass through the same and will be emitted from the tube so as to be available for therapeutic or other purposes.



Figures 1 and 2—Coolidge electron discharge device

Suggestions for the Experimenters' World

We will pay the usual prizes of $10, $5 and $3, in addition to our regular space rates, to the three contributors who send us the best manuscripts on the following subject:

WHAT RESTRICTIONS SHOULD BE IMPOSED UPON AMATEUR TRANSMITTING SETS IN RESPECT TO POWER INPUT AND WAVE LENGTH?

Limit your manuscript to 800 words.

Queries Answered

Answers will be given in this department to questions of subscribers, covering the full range of wireless subjects, but only those which relate to the technical phases of the art and which are of general interest to readers will be published here. The subscriber's name and address must be given in all letters and only one side of the paper written on; where diagrams are necessary they must be on a separate sheet and drawn with India ink. Not more than five questions of one reader can be answered in the same issue. To receive attention these rules must be rigidly observed.

Positively no Questions Answered by Mail.

L. W., Seattle, Wash.:

Ques.—(1) Referring to the book "Vacuum Tubes in Wireless Communication" which of the two circuits give the best results—figure 69 on page 103 or figure 80 on page 119?

Ans.—(1) These circuits are practically identical. The only difference is that figure 69 has a sensitizing circuit, L-6, C-6. Identical results are obtained from direct or inductive coupling, but as you well understand it is less difficult to adjust the coupling in a two circuit tuner than in a two slide coil. You are also aware that the coupling in figure 80 may be adjusted in the following manner—the sliding contact in the lower end of coil L-1 is moved towards the earth lead and sufficient inductance is added at L-2 with the other contact attached to the antenna until actual resonance is secured. The coupling can thus be gradually reduced to any desired value. From the standpoint of simplicity, figure 80 is recommended.

Ques.—(2) Would it be of any value to substitute variometers for inductances L-4 and L-5, figure 69?

Ans.—(2) If variometers were employed they would have to be of unusual dimensions, for these coils, if of the single layer type for the reception of long wave lengths, are from 24 to 30 inches in length and 4½ to 6 inches in diameter wound with No. 30 or No. 32 wire. The necessary closeness of adjustment for resonance can be secured by condenser C-2 for the plate circuit and C-1 for the grid circuit.

Ques.—(3) Would the addition of an audio frequency transformer in the secondary circuit, figure 69, be of any value in receiving damped waves?

Ans.—(3) Your query is not thoroughly understood. We do not know whether you refer to an audio frequency regenerative transformer or whether you propose to attach an audio frequency transformer in the plate circuit of the valve for cascade amplification.

Ques.—(4) Can such a circuit as figure 69 discloses be operated with two or three valves in cascade? If so, please give diagram and state capacities of condensers and size of inductances.

Ans.—(4) There are sufficient diagrams in this text-book to cover every possible requirement, and if you will study carefully the text, you will be able to devise a diagram entirely satisfactory for your use. An audio frequency cascade amplifier could be connected in the telephone circuit of this valve, using iron core transformers between the plate and grid circuits of successive tubes.

Ques.—(5) Will the circuits of figures 68, 69 and 80 operate equally well with either damped or undamped oscillations?

Ans.—(5) The circuit is applicable for the reception of signals from either type of transmitter. For the reception of damped oscillations, the apparatus should be adjusted just to the verge of oscillation, but for undamped oscillations the circuit should be set to oscillate at a radio frequency slightly different from that of the incoming signal. The beat phenomenon may be employed in the reception of damped oscillations with marked amplifications of the incoming signal, but the normal note of the spark transmitter will be distorted.

* * *

K. K. K., Elizabeth City, N. C.:

Ans.—(1) The wiring diagram for the receiving set shown in your recent communication is in error at two points. The secondary loading inductance L-2 is not connected in the circuit. It is merely attached to one end of the secondary coils of the loose coupler. It is also evident that you propose to regulate the plate voltage by a series rheostat. If you will stop to think over the conditions present in this circuit, you will see that a series rheostat of an extraordinary value of resistance would be required to get the proper voltage regulation. What you require in this circuit is either a multipoint switch which will connect the cells of the circuits in groups or a shunt potentiometer of about 3,000 ohms resistance. A semi-circular piece of graphite is usually employed to act as the potentiometer. In all other respects the diagram is correct, but for the reception of undamped waves you should have a certain amount of coupling between coils L-2 and L-3.

* * *

T. B., Freehold, N. J.:

Questions 1 and 2 in your recent communication are fully answered in the text-book "How to Conduct a Radio Club," on sale by the Wireless Press, Inc., 25 Elm Street, New York City.

Your third query in respect to providing means for varying the frequency of a "howler": The natural frequency of such a circuit is largely governed by the dimensions of the diaphragm. The frequency can be changed somewhat by adjusting the spacing between the magnets and the diaphragm or by proper design of the associated circuits. If you will send us a diagram of the particular "howler" you employ, we can then supply more definite data.

* * *

A. S., East Watertown, Mass.:

A number of diagrams have appeared in past issues of the WIRELESS AGE covering combination apparatus suitable for the reception of damped and undamped oscillations.

The natural wave length of the 125 foot aerial you propose to erect, after the ban is lifted, will have a natural wave length in excess of 200 meters. The flat top portion should not be more than 100 feet in length.

* * *

A gentleman who forgot to sign his name and address inquires:

Ques.—(1) Explain in simple terms, the construction and functioning of ampere hour meter.

Ans.—(1) A detailed explanation appears on pages 72 and 73 of "Practical Wireless Telegraphy" and no more simple explanation can be given. It is nothing more than a small motor which rotates in one direction as the storage battery discharges and the opposite direction as it charges. The motor is geared so that the scale indications are proportional to the ampere-hours of current flowing.

Ques.—(2) On page 187 of "Practical Wireless Telegraphy" it says that as a proper diagram for the government operator's examination figure 209 added to figure 207 will be satisfactory. Explain just how the connections are made.

Ans.—(2) You should have no difficulty in working out details of this diagram yourself. You will observe in figure 209, 8 connections for the volt meter. The terminals 3 and 4, for example, marked "battery unit A," should be connected across the terminals at battery A in figure 207 and so on with the remaining connections. In the Government examination you do not need to show the motor generator with automatic starter indicated in figure 207, but the terminals 5 and 6 in figure 207 should be connected to the "110 volts, DC" connections in the upper left hand corner of figure 111, page 98, of "Practical Wireless Telegraphy."

Ques.—(3) What is the function of the shunt condenser of the secondary receiving transformer?

Ans.—(3) The function of this condenser is to adjust the secondary or closed oscillation circuit to resonance with the incoming signal. By properly adjusting the inductance and capacity for a given wave length, the damping of the secondary circuit is thereby changed, permitting an adjustment favorable to the maximum strength of the signals.

When the coupling between the primary and secondary circuits is relatively loose, marked selectivity can be secured by the use of fairly large values of secondary capacity, but with loose coupling, smaller values of capacity will give the loudest signals.

Ques.—(4) What apparatus do you advise for the detection of undamped waves?

Ans.—(4) The best results are undoubtedly secured with the vacuum tube circuits, known otherwise as the self-heterodyne or "Autodyne." These circuits are completely described in the text-book "Practical Wireless Telegraphy" and "Vacuum Tubes in Wireless Communication."

Ques.—(5) I desire to join the N. W. A. To whom shall I apply?

Ans.—(5) Place your application with Headquarters at 25 Elm Street, New York City.

Electrical Digest

Reconstruction After the War

IF we have correctly sensed the attitude of our contemporary The Electrical Review, there will be no room after the war for the industrial leader with pessimistic ideas. An inevitable readjustment of industrial affairs must follow, but if we believe that unsurmountable chaotic conditions will prevail, we are following a line of argument that will lead into just the condition which is to be avoided.

Business men must make an extraordinary effort to maintain a mental poise during this period. They should not be over optimistic or over pessimistic. Such well-known men as Otto Kahn, the great New York banker, believes that although "the immediate sequence of the ending of the war is bound to be an interval of confusion and readjustment, during which certain industries will be favorably or unfavorably affected, at the completion of the process there should be for a few years at least an immensity of opportunity and a corresponding prosperity producing activity such as even this country has rarely experienced."

We are urged to recognize and respect the demands of the new day, which is a day of progress and social justice and of the searching and testing for the right.

In a recent editorial, the Electrical Review urges that Congress should take up a definitely charged body with the numerous problems involved and the drafting of the most practical solutions thereof. One of the conditions on which a satisfactory solution is based, is the establishment of goodwill between employers and employes.

The Review states editorially:

"Relations between employers and employes must be determined on the basis of mutual fair play and enlightened goodwill; there must be an adjustment of occupations to care for the returning of soldiers and at the same time accord adequate recognition of female labor in our industries; there must be a readjustment of tariff schedules to guard against an influx of hoarded goods from present enemy countries; the thousands of plants now busily engaged in the production of munitions of war must be adapted or readapted to their normal or newly developed peaceful pursuits. These are just a few of the hundreds of equally insistent questions that must be considered and on which the future permanent prosperity of this country must depend.

In approaching the problems of the reconstruction period we should not be carried away by optimistic hopes that they will not be of great importance or will somehow automatically solve themselves. Preparedness for post-war conditions is as important as for war. Nor must we work at cross purposes. We must co-ordinate our efforts as we now are doing, in order that we may achieve the greatest good for the greatest number. This evidently calls for a definite program of action on broad national lines and it is to lay down the groundwork for this that a national reconstruction commission is desirable.

The details of any national program must, however, be worked out by the industries themselves and in this connection the task of the electrical industry is a stupendous one.

The Naval Psychiatric Unit

ARE you temperamentally or otherwise unfit to become a wireless expert? Possibly so, but if uncertain on this point, you will soon ascertain your standing after joining the Naval radio school at Great Lakes, Ill., for they have inaugurated a Psychiatric Unit, the sole purpose of which is to determine the education, mental alertness and all-around qualifications of their students.

The examinations are under the supervision of Chief Yeoman Johnson and his specially trained staff of assistants, who give their students a thorough drilling on such general subjects as, reading, writing, arithmetic, ability to take dictation, the translation of their notes into long-hand, and such other general questions as seem applicable to a well-balanced radiotelegraphic expert. Of course, the primary object of the test is to eliminate men who apparently could not progress rapidly enough for the requirements of the government service.

The examinations of the Unit were evidently of great value, for it was found, after a sufficient number of cases had been investigated to determine fully the accuracy of the Psychiatric tests, that 95 per cent. of the men examined either progressed or failed in accordance with their previous judgment. Quoting a recent article in the school publication Radio Sparks:

"It was found that in practically all cases where the men were examined the men themselves were satisfied with the finding of the psychiatric unit and fully agreed to the transfer if it was suggested. In a few cases, however,

individuals insisted that they were able to learn radio and requested that they be allowed to continue for a sufficient length of time to determine whether or not they could make satisfactory progress. In a number of these special cases the men actually did make good, but the great majority of them finally agreed with the examiner that they were not fitted for radio work.

"When it is evident that a man is not fitted for radio work, the psychiatric unit takes special pains to determine in what branch of the service the man belongs, and arrangements were made with the various departments needing specially qualified men, to transfer to them such men as seemed especially fitted for work in their department. This gave such good results that in quite a number of instances the heads of these departments informed the officer in charge of the Radio School that the Radio School was able to select better men for their departments than they were themselves, and this feature also added considerably to the good feeling existing among the men assigned to duty in the Radio School. They were thus assured of what is commonly called a 'square deal' and took the examination fairly and even enthusiastically."

Close to 25 per cent. of the men assigned to duty at this radio school are in this manner eliminated, the tests showing that they were inapt for radio work.

In fact, the success obtained at this training school has in no small measure been credited to the correct selection of the personnel by the Psychiatric Unit.

A similar procedure has been employed by the Marconi Institute for some years past. The students being queried on such general questions as "How far is the sun from the earth?" "What is the average time to take a train trip from New York to San Francisco?" "Name the seasons of the year in the zone in which your school is located and the approximate dates of their beginning and ending."

This test is followed by simple questions in arithmetic—division, decimal fractions and such other arithmetical problems as were deemed necessary to insure the students' progress. Such tests show to the student how little he retains in mind of the actual and fundamental facts of matters pertaining to every day occurrences and to say the least, they tend to sharpen his wits.

Our good wishes go forward to the Psychiatric Unit of Great Lakes for they undoubtedly have performed a great work for the government.

Book Reviews

Aero Engines, Magnetos and Carburetors. By Lieut. Harold Pollard. Cloth binding, 4½x5¾ inches, 84 pages. Macmillan. Price $1.00 net.

Those to whom the mere mention of the various parts of a gasoline engine are bewildering may learn from this little pocket volume what they are and how they function. While the book does not reach the proportions of a technical work on aero engines, it will serve adequately to introduce the subject in a reader's spare hour. In every sense it is a text for a beginner; easily understandable explanations of the general considerations are adequately illustrated by thirty-one diagrams.

Obtainable through the Book Dept., THE WIRELESS AGE.

Aeroplane Construction and Operation. By John B. Rathbun. Cloth binding, 5¾x8 inches, 415 pages. Stanton & Van Vliet. Price $2.00 net.

A compromise between the layman's books and highly technical airplane treatise has been arrived at in the preparation of this volume. Its principal feature is the text on calculations for surface, power and weight, although the aerodynamic principles and construction details are given considerable attention and are well illustrated. The volume follows the usual textbook form, first defining and classifying airplane types, applying aerodynamic principles to wing sections, discussing construction of these in detail and considering quite exhaustively fuselage and chassis construction. The factors of weight, balance and stability and head resistance are valued and power calculations made. A chapter is devoted to operation and training methods followed by a brief one on the characteristics of aeronautic motors.

Those who have had some technical education and are interested in the engineering phases of aviation will find the book of value. The trained mechanic and future designer are adequately served on the subjects of wing and body structure, and the author's expressed hope that "the book will serve to inspire the technical reader to deeper interest and practical research" in aeronautics should be fully realized.

Obtainable through the Book Dept., THE WIRELESS AGE.

Aeroplane Construction and Assembly. By J. T. King and N. W. Leslie. Cloth binding, 6x9¼ inches, 115 pages. Dunwoody Institute.

As its title implies, this book specializes in airplane rigging. The Curtiss machine is used to explain the principles of assembly and alignment, and is progressively considered from the time it arrives in a packing case until the running gear, wing and control surfaces have been assembled, attached, adjusted and aligned. The required inspection and preparation of engine and propeller prior to flight is then detailed and cautions and instructions for general inspection given. Materials and functions of the various structural parts are considered in detail and a final chapter co-relates the individual rigging problems by a concise explanation of the theory of flight.

As a means to a practical understanding of the work of the aviation mechanic concerned with the airplane structure's erection and assembly, the book is assured a distinct place in aviation literature.

Obtainable through the Book Dept., THE WIRELESS AGE.

Practical Flying. By Flight-Commander W. G. McMinnies, R.N. Cloth binding, 5½x8¼ inches, 246 pages. Doran. Price $1.50 net.

As the three volumes just reviewed are concerned with the mechanics' problems in aviation, this book is almost entirely designed for the aviator. The practical considerations of flight is the author's subject, beginning with qualifications and causes of engine trouble, preliminary to a chapter on the governing principles which make for success during the first lesson in the air. Solo flights and the use of the instruments are then described, completing the preliminary stage. Map reading, preparation and airmanship in cross-country flying, successively follow. Advanced flying is then considered in many aspects: high altitude, acrobacy and air navigation at night being the principal divisions. A chapter on growth of confidence, from both instructor's and pupil's viewpoints concludes with a supplementary discussion of medical aspects and provision of suitable clothing. An appendix carries a glossary of terms and condensed hints for flying efficiency through elementary and advanced stages.

Sound advice and valuable hints on personal flying efficiency both for the beginner and the flier still under instruction but in more advanced stages are contained in generous profusion throughout the pages. Careful reading of the volume will undoubtedly improve the airmanship of nine out of ten pilots and certainly will enable the beginner to avoid the mistakes commonly made.

Obtainable through the Book Dept., THE WIRELESS AGE.

The Shipbuilders' Blue Book. By Walter Kay Crawford. Cloth binding, 4x6 inches, 79 pages. Ocean Pub. Co. Price $1.50 net.

The definite announcements of the colossal shipbuilding program to be continued by the United States, adds special interest to this book. The men who are to engage in this industry have little to guide them on the assembly of the various steel plates of which a ship is constructed, and it is to the definition and explanation of the work of the shipfitter that this handbook is devoted. The special rules and requirements of this planning and assembly work are given, the problems of riveting and the approved methods are shown, the basic principles of ship construction being graphically presented by twenty drawings and simplified supporting text. It condenses the thirty years of Mr. Crawford's experience as a shipbuilder and, as information from a thoroughly practical man, will find a ready welcome among those who will engage in the construction of the new American merchant marine.

Obtainable through the Book Dept., THE WIRELESS AGE.

Mahan on Naval Warfare. Edited by Allan Westcott, Ph.D. Cloth binding, 5½x8 inches, 372 pages. Little, Brown. Price $2.00 net.

One does not attempt to gild the lily by saying anything in praise of the works on naval warfare of Rear Admiral Alfred T. Mahan; his writings are not only standard on the subject, but the leading expressions in that difficult field. It but remains, then, to note on the present edition that the editor, an instructor at the U. S. Naval Academy, has accomplished to entire satisfaction the concentration in one book of the basic opinions of the world's authority on sea power and naval strategy. Mr. Westcott has not condensed; he has selected from the many Mahan writings the best that value the influence of sea power, define the principles of naval warfare and apply the lessons of the past to the present and future. Thus the compact volume brings to the seafaring man a book easily termed indispensable to a full understanding of his task of assisting in safeguarding the shores of his country and his function on the wide reaches of the sea.

Obtainable through the Book Dept., THE WIRELESS AGE.

Winning and Wearing Shoulder Straps. By Lieut. Col. Charles F. Martin. Cloth binding, 4½x5½ inches, 105 pages. Macmillan. Price $1.00 net.

Colonel Martin's little book is a study of the art of command, responsibilities of the army officer, the required efficiency and the psychology of leadership. The advice throughout is sound, and it is of a character that is perhaps best termed advisory. The heart-to-heart talk style of presentation give each point emphasized a "sticking" quality that may serve an officer through many trials long after the source of the knowledge is forgotten. To men still abroad who have the guidance of troops on irksome police duty its direct psychological analysis of the soldier should prove invaluable; and to the many officers who will return to civilian life but still remain on the reserve list, it will concrete experiences and analyze any errors in administration the source of which may not yet be clear.

Obtainable through the Book Dept., THE WIRELESS AGE.

Do's and Don'ts for New Soldiers. By Major Harlow Brooks. Cloth binding, 4½x5½ inches, 83 pages. Macmillan. Price $1.00 net.

Another handy pocket book for soldiers on duty overseas during the aftermath period is met with in Major Brooks' text. Pertinent subjects are: police duty, care of the body, what to do when sick or wounded, what to study and remember, the attitude of the soldier toward civilians and when in conquered territory, military courtesy and customs of the service.

Obtainable through the Book Dept., THE WIRELESS AGE.

A General's Letters to His Son on Minor Tactics. Cloth binding, 4½x7 inches, 95 pages. Doran. Price $1.00 net.

The anonymous author of this handbook observes a fact well known to officers of the regular establishment: that many men who are in other ways excellent instructors have not the facility for constructing problems with a point. So for officers following civilian pursuits except in emergency, he has done a distinct service in his twelve problems in minor tactics; with these as a basis, proper reformation may be looked for in the method of conducting officers' schools in the militia. The problems have a new pattern, and a very useful one because of entire applicability to actual combat. Too much stress, it may well be said, has in the past been given to the maneuver type of tactical exercise. Lamentably little time has been devoted to ranging for rifle fire, the importance of which is well emphasized in this work.

To illustrate the value of the text it might be remarked that the writer of this review, a typical civilian officer, set out to solve the problems before consulting the answers, with the following result: seven were solved correctly; four solutions were partially correct; one solution was entirely wrong. Yet the author's answers were obviously correct and led the reviewer to wonder how he could have failed of 100 per cent. correct solution. The obvious reason is that the type of problem was unfamiliar, just as would be the case in at least 90 per cent. of reserve officers otherwise well qualified for leadership.

The little volume is a necessity to militia officers who take their responsibilities seriously.

Obtainable through the Book Dept., THE WIRELESS AGE.

February, 1919

20 Cents

The WIRELESS AGE

Volume 6 Number 5

An Aviator's Wireless Telephone Equipment Showing the Transmitter and the Receiving Helmet

Amateur Attacks on Government Ownership

The Wireless Age

Edited by J. ANDREW WHITE
E. E. BUCHER, Technical Editor

Vol. 6 — Contents for February, 1919 — No. 5

Index of Equipment

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GREAT BRITAIN
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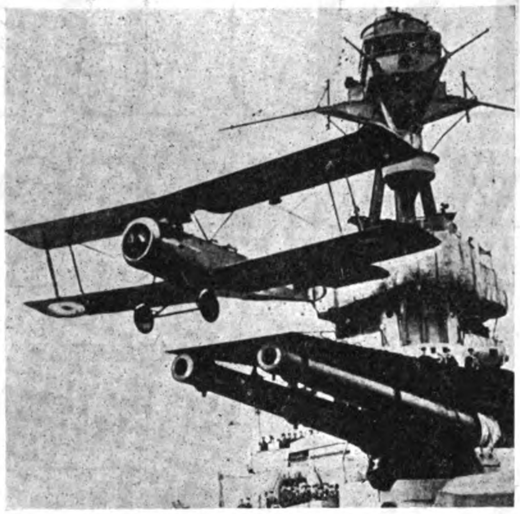
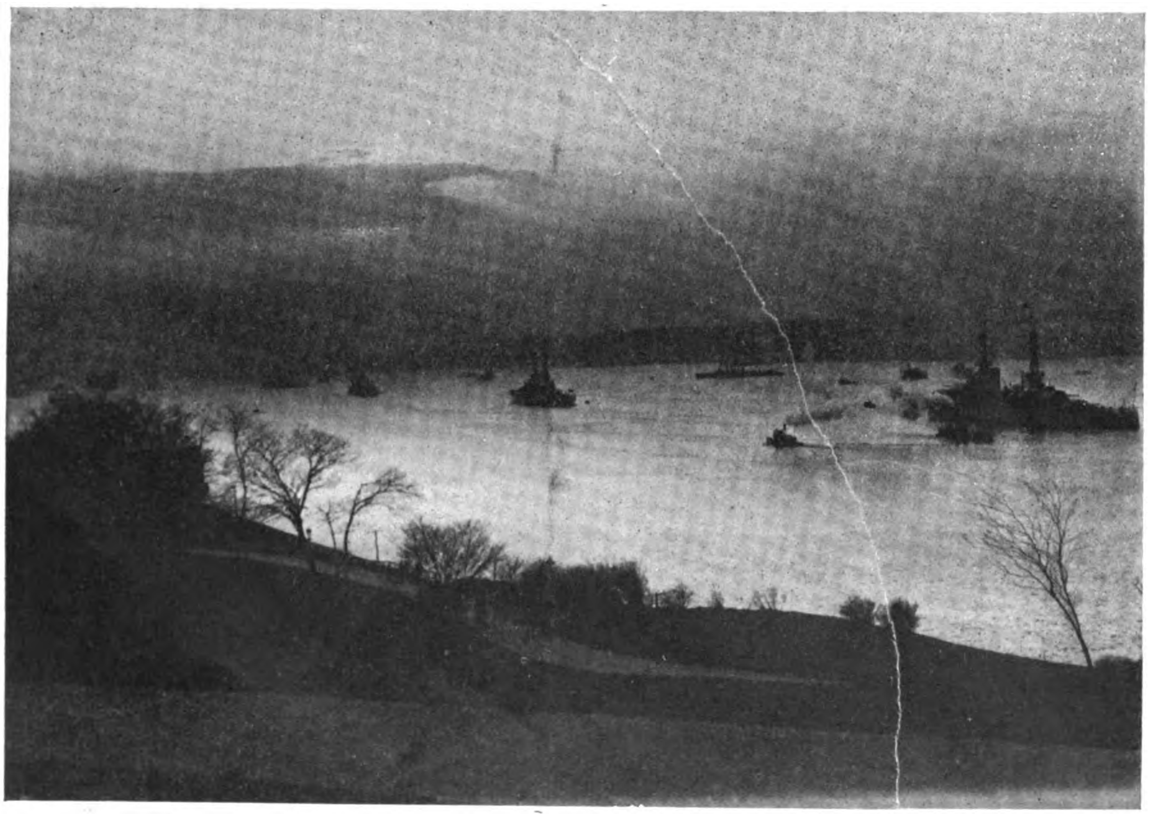
97 Clarence St., Sydney, N. S. W.

New Uses of the Air



Above: How the naval air scouts were launched on their daily patrol missions in overseas waters

To the left: Colonel Culver directing by wireless telephone four army airplanes flying in formation over Washington. The planes were at a height of 2,000 feet. With Col. Culver is Senator Warren; General Kenly is at the right of the picture



Photos by Int'l.

When the battle fleet arrived in New York the first greeting was given by wireless telephone

VOL. 6. No. 5. FEBRUARY, 1919

THE WIRELESS AGE

WORLD WIDE WIRELESS

Another Five Per Cent Dividend for American Marconi

AT a meeting of the Directors of the Marconi Wireless Telegraph Company of America held at the offices of the company on January 14, 1919, a dividend was declared out of surplus profits at the rate of 5 per cent on outstanding stock. This return on the common stock is payable July 1, 1919, to stockholders of record at the close of business June 2, 1919.

The dividend is the third declared by the American Marconi Company, the first, 2 per cent, being in August, 1913, and the second, 5 per cent, paid six months ago, August 1, 1918.

Navy Announces Underground and Water Wireless

HOW underground and through-water wireless, or induction telegraphy, was put into practical use during the war was disclosed on January 11 by Navy Department officials, giving to the public another of its secrets carefully guarded so long as it might be of value to the enemy. This development originated in private research by James H. Rogers, a scientist of Hyattsville, Md.

In practical use the new system so far is employed only for receiving radio messages sent out from powerful stations in Europe. These are now being read at underground receiving stations in the United States.

In addition, it was revealed at the department, through an adaptation of the Rogers theory, submarines under water are intercepting radio signals sent from shore. With crude apparatus the scientist has succeeded in transmitting signals two miles from a submerged wire simulating a submersible.

Officials say it is possible, although not yet an accomplished fact, that ground or water sending can be developed to a considerable extent. They do not anticipate, however, that the present method of sending from high towers will be superseded, except for special purposes.

The theory most generally held until Rogers demonstrated the correctness of his views was that impulses hurled into the air from a radio transmitting station and deflected earthward became dissipated, as does lightning, when they struck the ground or water. The Maryland scientist, however, believed that the impulses flowed through the earth as through the air and that it was only necessary to trap and measure them in the ground.

Mr. Rogers had been at work on this theory before the United States entered the war and already had interested naval experts. He offered the results of his work to the navy without restriction, and when they were accepted after some demonstrations at Hyattsville, officials say, he was with difficulty persuaded to accept even remuneration for actual time given to co-operation with the government.

One of the first steps taken was the request of the Navy Department, under war legislation, that his application for patents be expedited. This was done.

Some of the main advantages of the Rogers system as developed so far, according to the experts, are almost negligible cost of construction, the intensifying of signals by pointing the sending apparatus toward the receiving station and reduction of static interference. Because of the latter advance the navy's receiving station at New Orleans, where communication with ships in southern waters swept by frequent electrical storms is maintained, uses the underground apparatus with marked success.

James H. Rogers and his new underground and undersea wireless used by the Navy during the war

In war a great advantage is that submarines receive messages while submerged. This is being done by wires trailing in the water.

Trans-Atlantic Radiophone When Peace Treaty Is Signed

WE will be talking across the Atlantic ocean by wireless telephone by the time the peace treaty is signed, according to Godfrey Isaacs, managing director

of the Marconi's Wireless Telegraph Company of England. In a press interview he is credited with saying that as soon as war restrictions are removed, the development of wireless telephony will go ahead at a surprising rate.

"One day in the not distant future," he said, "we will walk about with wireless telephones attached to our bodies, and will be able to call up a friend, say from Picadilly Circus, who is flying somewhere. Or one may have a wireless telephone invitation from a friend flying in France to join him at dinner.

"It will not be very long before one will be able to sit at one's desk in London and speak to New York practically instantaneously. It will be quite as easy to speak with Paris, Rome, Amsterdam, Moscow, Sydney, Melbourne or New Zealand.

"We are arranging for large organizations whereby we shall always be in wireless telephonic communication with airships, to keep them informed concerning meteorological conditions."

Cheapening and quickening of news transit and expediting of trade and industry are among the immediate results predicted by Mr. Isaacs.

The Bump of Repentance
—*Nelson Harding in the Brooklyn Eagle*

War Ban on Wireless Messages Lifted

The War Trade Board has lifted the ban on the use of the radio by commercial vessels in the Pacific and Atlantic oceans west of the fortieth meridian. This restores the use of the radio to conditions existing before the war.

The only restriction against its use now is in connection with the blockade, no communication with the Central Powers being permitted. The War Trade Board previously had rescinded its restrictions on use of the cables.

Relatives and friends of soldiers returning on transports from overseas may communicate with them by wireless and receive answers.

Messages may be filed at any telegraph office and will be relayed to a naval radio base.

Charges via New York are sixteen cents a word, including telegraph tolls. Persons so desiring may pay in advance for answers.

No message will be accepted until the ship for which it is destined has passed half way across the Atlantic.

Salary Increases for American Wireless Operators

The special wage commission authorized by United States Shipping Board unanimously reached the decision that salaries to be paid wireless operators on vessels operated from Atlantic and Gulf ports, effective January 1, 1919, to be as follows: All chief operators, $110; all assistant operators, $85. There are to be no trans-Atlantic or coastwise bonuses, and no sliding scales.

Wireless Phone Commercially Practicable

John C. Parker, professor of electrical engineering of the University of Michigan, believes that it will be commercially practical to use the wireless telephone for long distance and middle distance calls.

"While a sending apparatus is expensive, and the cost of operation is greater than by wire, the total initial cost without wires will be so much less than that with hundreds of miles of wires that the wireless, as now developed, will be more economical," Prof. Parker says.

"It will be more dependable. Static disturbances have been practically eliminated, so storms will not interrupt service, whereas heavy storms put many wires out of business.

"For regular standard wire business, the radio or wireless telephone should supersede the telegraph and the wire telephone. It would be possible for one newspaper service, for example, speaking through one transmitter, to give news to thousands of different papers at the same time. It is impossible to compute the load this would take off the telegraph wires. The man talking through the wireless transmitter could be heard by as many persons as had receivers tuned up to the wave length the transmitter was sending."

Joseph H. Cannon, associate professor, said it would be entirely possible for the President of the United States to speak from the White House into a radio telephone and be heard by everybody in the United States who could get a receiver tuned up to his.

"On ocean and lake ships it would be entirely practical to install radio telephones, connected with wire telephones on the shore that would give direct, verbal communication between persons on shore and ship," Prof. Cannon says. "When we have airplanes carrying passengers between Chicago and New York the passengers could keep in touch with developments on the stock market minute by minute. The baseball or football enthusiast could follow his game play by play, as if he were in a club and the returns were coming by ticker."

Marconi Service for Passenger and Mail 'Planes

Godfrey Isaacs announced on December 18 that Marconi's Wireless Telegraph Company, of London, would outfit airplanes employed in air passenger and mail service with wireless and would supply operators in the same way as it now serves ships. It also is intended to receive regular reports of air conditions in different localities and to circulate these for the information of the pilots. As every airplane will have either a name or distinguishing number, it will be possible to send telegrams from any part of the world or from any ship to an airplane. It is intended that this organization will be ready by the time the peace treaty is signed.

Arrangements recently have been made for the erection of wireless stations in the extreme parts of China, one on the frontier of Cashmere and another on the Chinese side of Siberia. Mr. Isaacs has arranged with Handley-Page for the transport of the necessary machinery by one or more of his big machines. The journey inland will take two or three days instead of months.

War Radio Hero Found a Job Waiting

WEARING the Croix de Guerre with a palm, which had been pinned upon him by Premier Clemenceau of France, Sergeant Elias A. Kimball of Co. E, Second Telegraph Battalion, applied recently for a job at the Labor Bureau in the Hall of Records, New York.

"I've had enough of war; what I want now is work," Kimball said.

At Belleau Wood, he and eight comrades were operating a radio outfit when the Germans opened a barrage and the aerial was blown into No Man's Land. Six men tried to bring them back. They were killed. The Major in charge of the party crawled out, but was hit and incapacitated. Then Kimball wriggled his way forward and brought back the wires and the injured Major. For that he got the French War Cross.

Later, at Soissons, he won the palm by sticking to his radio apparatus during a heavy fire and a terrific electric storm. Lightning finally struck his mechanism and knocked him unconscious. When he recovered he was in a Paris hospital.

Sergeant Kimball got his job from the Labor Bureau.

Radio Essential Equipment on Modern Aircraft

SOME details of the development of the airplane radio telephone set which is featured on the cover of this issue were given by Major General George O. Squier, Chief Signal Officer of the Army, in a paper recently read before the American Institute of Electrical Engineers.

On May 29, 1917, the Chief Signal Officer called a conference in his office to set in motion the project of evolving a "voice command" equipment for airplanes which should meet all the severe requirements of the military service and which should be thoroughly standardized for quantity production. Speech was exchanged between airplanes twenty-five miles apart in October, 1917, and sample sets were sent at once to the army in France, for trial. Several thousand sets were ordered and have been completed and distributed to flying-fields here and to the Air Service in France.

The radio equipment consists of the vacuum tube transmitting and receiving set, and the special telephone transmitters and receivers. General Squier, referring to the latter, said: "Those of you who have heard the terrific roar of a Liberty engine will realize the difficulty of talking in an airplane in flight. The development of a transmitter which is affected by the human voice, and not by the enormously greater engine and wind noises, is one of the principal features of this set. Similarly, to shield the ears of the aviator from the same noises required a special combination of sound-insulating materials surrounding the telephone receivers and suitable for use within an aviator's helmet."

The antenna originally consisted of a flexible copper wire several hundred feet long, unreeled by the aviator and trailing almost horizontally behind the airplane. Modified antenna using much shorter wires fixed to the framework are now used.

The operation of the sets is extremely simple, all adjustments being made before leaving the ground. The only manipulation required of the aviator is that of the changeover switch to change from talking to listening.

Valuing the remarkable advances recently made in radio, General Squier said: "Commercial and military possibilities have, however, hardly been touched as yet. It is believed that radio apparatus soon will be as essential on aircraft as it now is on ocean-going steamships, and that its use will enormously increase the effectiveness of aircraft for all purposes."

Royal Society Chairman Recognizes Future of Wireless Press

IN a recent address on "Science and the Future," delivered before the Royal Society of Arts, in London, by its chairman, A. A. Campbell Swinton, interesting comments were made on the recent achievements and new possibilities of wireless communication.

"One matter, however, is within public knowledge," he said, "and that is the increased and still increasing amount of news that we get in the papers that appears under the heading of 'Per Wireless Press.' Indeed, wireless telegraphy appears to be developing at last in what has always appeared to me to be its proper field, which is not so much to communicate between one individual and another, but rather for the communication of intelligence broadcast over the earth. No doubt maritime wireless communication between ships, and between ship and shore, hitherto its most useful application, is another case altogether, and supplies a want that telegraphy by wire cannot meet at all. With this we are already familiar, while the use of wireless as a voice that can speak simultaneously to points on every portion of the earth is in some ways a more novel proposition.

"No doubt some persons who had private wireless stations of their own before the war, were used to get-

The girl he left behind him
—*Thomas in the Detroit News*

ting time signals from Paris from the Eiffel Tower, and from Nauen in Germany while a few of those who had mastered the difficulties of reading the Morse alphabet by ear, were able to decipher weather reports from these places as well as from our own Admiralty, in addition to general news from Poldhu in Cornwall, and from one or two other large stations.

"What I have in my mind, however, goes much farther than this. In London tape and column-printing telegraph instruments operated by wire, that record sporting, parliamentary and general news, have long been familiar objects in clubs and hotels, and have become a portion of our daily life. Now there is no reason at all why similar printing instruments, which he who runs can read, should not be operated by wireless means, not only in London and other large cities, but throughout the country, or even throughout the world. Special transmitting stations using different wave-lengths could send out the messages, while separate printing machines, tuned each to respond to the wave-length of a particular trans-

mitter, at each required point, would receive and record them. No connecting wires, costly both as regards first expense or as regards upkeep, would be required, but only suitable aerials at each transmitting and receiving station.

"Some regulations would be necessary to prevent interference, and as wireless waves, traveling as they do through the ether of space at the enormous speed of 186,000 miles per second, recognize no international boundaries, they would have to be universal. Thus arises a fitting opportunity for the league of nations. For the distribution of news to the press nothing could be better or more economical, while there is no reason why clubs, hotels and private houses everywhere should not also be thus supplied with the latest intelligence. For in wireless telegraphy it costs no more to send signals to a thousand receiving stations than to a single one, and there is practically no limit to the number of stations that can simultaneously receive signals from a single transmitting station.

"To some, this sketch of the universal distribution of news to all and sundry may appear fantastic, but it is not really so at all; for at any rate as concerns an area no larger than Western Europe and the British Islands, it is well within the range of practicability at the present time, and only requires a little working to arrive at the best arrangements."

Radio Service to South America an Imperative Need

IMPERATIVE need of direct cable connections, supplemented by radio service, between the United States and South America as the first and most important step in the development of relations between the American continents, is emphasized in a report made to Secretary Daniels by Captain C. T. Vogelgesang, just returned from Brazil as chief of a naval mission.

"The field is at this time open to energy and enterprise," the report says, "and if United States capital, backed by a strong and enduring policy of Government support, does not avail itself of the golden opportunity that is now presented, foreign capital will control and we will not have established that community of interest that Brazil looks for in her relations with us."

Wireless to Relieve European Cables

ORDERS were issued by Postmaster General Burleson on January 4 for routing by wireless all Government cable messages addressed to Europe unless specifically stamped "not to be sent by radio." The order does not apply to private cable messages, those sent by individuals or business firms, and does not apply to confidential Government messages.

Routing of Government messages by radio wherever possible was determined upon because of congestion of the cable lines.

Both the War and Navy departments have been asked to co-operate in radio use and to instruct officers in Europe to use radio for official messages wherever possible.

Fiji Islands Connected with New Zealand

A WIRELESS station has been established at Avarua, the principal town and port of Rarotonga, that now practically connects up a chain of wireless stations between the Fiji Islands, Tahiti and Rarotonga with New Zealand.

Service to Hawaii and Japan Resumed

AFTER suspending ten months, commercial radio communication between San Francisco, Hawaiian Islands and Japan was resumed December 19 at midnight.

Lieutenant-Commander C. R. Clark, Pacific Coast communication superintendent, stated Government stations will handle the traffic. The San Francisco station is at South San Francisco and the Hawaiian station at Pearl Harbor. The Japanese station at Funibashi is controlled by the Japanese Government.

Under the Government plan, messages for Japan will be received only from San Francisco and bay cities. Messages may be filed in any part of the United States for the Hawaiian Islands. Western Union offices will receive messages for delivery to naval stations. Due to congestion and the limited service, only full-rate messages will be accepted. All messages will be subject to censorship. Information concerning the certain codes which may be used may be had from the office of the Chief Cable Censor.

Before the war the Marconi Company handled commercial radio traffic to Japan. This service was suspended February 21, this year.

France to Get American Overseas Station

THE French government is expected soon to take over from the American Navy what will ultimately be the most powerful wireless station in the world. It is located at Croix d'Hins, near Bordeaux, and will consist of eight towers, each more than 800 feet high. It will be able to transmit messages not only to all parts of the United States, but perhaps even to Honolulu. Construction was begun a few months ago by the American Navy for the American Expeditionary Forces, with the understanding that ultimately it should be ceded to France.

Naval War-time Radio Included 4,000 Stations

"NAVY NIGHT" in the thirty-ninth annual meeting of the American Society of Mechanical Engineers was signalized by two events of more than usual timeliness and popular news interest. Before an audience which filled the auditorium of the Engineering Societies Building, in New York, Lieutenant Commander William L. Cathcart, U. S. N. R. F., lectured on "The Achievements of Naval Engineering in the War," with special reference to the Bureau of Steam Engineering of the Navy

Recounting the achievements of the electrical division, Commander Cathcart said:

"Under the supervision of the radio division there are now more than four thousand radio installations on board vessels flying the American flag. The bureau's direction," said Commander Cathcart, "extends similarly to fifty naval radio coastal stations and seventy-five commercial coastal stations in this country; to others in the West Indies and the Canal Zone, in our island possessions, and Alaska and Vladivostok in the Pacific, and finally to one now building for us at Bordeaux, in France, which will be the most powerful wireless station in the world.

"Communication between Washington and Russia will be made through the establishment of the Vladivostok station, now nearing completion. Our communications with China are through Cavite, and our Asiatic fleet to the United States Naval Radio Station at Peking."

Amateur Radiotelegraphy of the Future*

By Alfred N. Goldsmith, Ph.D.

Director of the Radiotelegraphic and Telephonic Laboratory, College of the City of New York

EDITOR'S NOTE—The author advocates operating all amateur radio stations of the future on sustained waves between 100 and 300 meters. He points out the desirable results of such a change, including a forty-fold increase in the number of stations operating within a given zone without interference, together with the immediate possibility of radio telephony.

I AM compelled by circumstances not to describe the actual construction of any particularly desirable transmitter and receiver. So detailed a prophecy as to the future of amateur radio communication seems to me ill-advised and calculated to do more harm than good. I prefer to indicate a line of future development, of a radical but practicable type. In so doing, it is my hope that an impetus will be given toward the development of the necessary equipment, so that those parts thereof which are now existent will be supplemented by the remaining new portions of the apparatus.

It is evident to even the most casual observer of radio telegraphy on a commercial scale during the last fifteen years that the tendency has always been strongly toward the use of sustained or "undamped" waves. Starting with the old-fashioned "spark-in-antenna" type of set, with its almost incredibly high damping and equally incredible capacity for the creation of intolerable interference with the work of other stations, the art progressed first to the inductively coupled stationary spark set of the old "United Wireless" type. Later came the modern quenched spark sets, these radiating waves of a damping of the order of 0.1. Were it not for the absurd regulation which practically places all ship and shore stations on a single wave length of 600 meters, these quenched spark sets would probably give a good account of themselves in the way of reducing interference. As it is, however, the full use of the available wave lengths is much restricted. Certainly it is to be hoped that in this, as in many other particulars, the present unwise radio regulations will be drastically amended.

The Sustained Wave and the Beat Receiver

But the evolution of the commercial transmitter has gone even further. There exist to-day at least three different types of fairly high-power sustained wave generators, namely the Poulsen arc, the vacuum tube oscillator, and the radio frequency alternator. All of these are in actual use, the first and third preponderating at present. With the advent of sustained waves, the receivers employed had to undergo fundamental changes. A whole series of new devices were evolved for sustained wave reception, notably the tikker, the tone wheel, and the beat method of reception. It is on this last method that I would center the attention of the reader. For it is my belief and hope that the amateur of the future will work with short sustained wave transmitters and beat receivers. In that direction I see really unusual opportunities for the earnest and ambitious worker.

*Abstracted from a paper prepared for the Radio Club of America. 1916.

Of course, the tendency toward low damping in amateur transmitters and receivers is very marked, quite apart from the 0.2 decrement regulation of the Government. Many amateurs are using quenched, or rotary synchronous, or non-synchronous gaps, and are doing work on low damping. The attempt to reduce the decrement of the receiving set is equally well marked. It only remains to carry this tendency to its ultimate, desirable, and logical conclusion.

The evils of high damping are very obvious, yet a brief calculation may not be amiss. Suppose that the decrement of the spark transmitter is 0.2 and that the decrement of the receiving set is also 0.2. Suppose further that the wave length is 150 meters. The question is: how far must the receiving set be detuned so that the signal strength is reduced to one-half? A simple calculation will show that a change in wave length of 10 meters is sufficient. That is, if we assume that we can read a message through interference of half its strength, a receiving operator could read at will any one of three stations at 140, 150, or 160 meters respectively. This is also on the assumption that the three stations come in equally loudly at resonance. Unfortunately these conditions are not always realized in practice, and if one of the three interfering stations should happen to be exceptionally near or exceptionally powerful, its interference would be difficult if not impossible to overcome.

Operating 400 Stations Without Interference

I believe that the basis of decrement and ratio of desired-to-undesired signal given above is a fair one for comparative purposes. If so, we could not have more than about 10 stations working between 100 and 200 meters without causing serious interference. And this, too, under the most favorable conditions of equal-powered stations at equal distances from each other. The present-day excessively difficult conditions in thickly amateur-populated districts become immediately explicable on the above basis. It is clear that a radical change is needed so that every amateur can be reasonably secure from interference. It is for this reason that the sustained or "undamped" wave transmitter and beat receiver are advocated.

Fortunately enough, the beat receiver is particularly well suited to use at the short waves which are favored by the amateur. Interference is much less with beat receivers on short waves than at the long waves used by commercial stations. The following calculations will show this point clearly: Let us consider a large commercial station working, say, at 10,000 meters. This corresponds to a frequency of oscillation in the antenna of 30,000 cycles per second. If we receive this on a beat receiver, e.g., the ultraudion or one of the

well-known Armstrong circuits, the receiving audion must be producing oscillations about 500 cycles more or less than those of the incoming wave. In this case, that frequency would be either 29,500 or 30,500 cycles per second for the local vacuum tube. It is found that the beats become quite faint and practically inaudible when we get more than 3,000 per second of them. That is, the range between 27,000 and 33,000 cycles per second must not be encroached on by an interfering wave. If it is, we shall get audible beats and interference between the desired and the undesired waves. Consequently we tie up the entire range of wave lengths between about 9,100 meters (corresponding to 33,000 cycles) and 11,100 meters (corresponding to 27,000 cycles). Stations must lie about 9 per cent apart in wave length at 10,000 meters for perfect beat reception. Thus, between 10,000 and 20,000 meters, only about 6 or 7 stations could work successfully on this basis. When we go down to 200 meters wave length (corresponding to 1,500,000 cycles), we find a much more favorable state of things. The limits of interference now lie between frequencies of 1,503,000 cycles and 1,497,000 cycles. These correspond respectivly to 199.6 meters and 200.4 meters, and are only 0.3 per cent apart. We will tabulate these and a few other results for comparison.

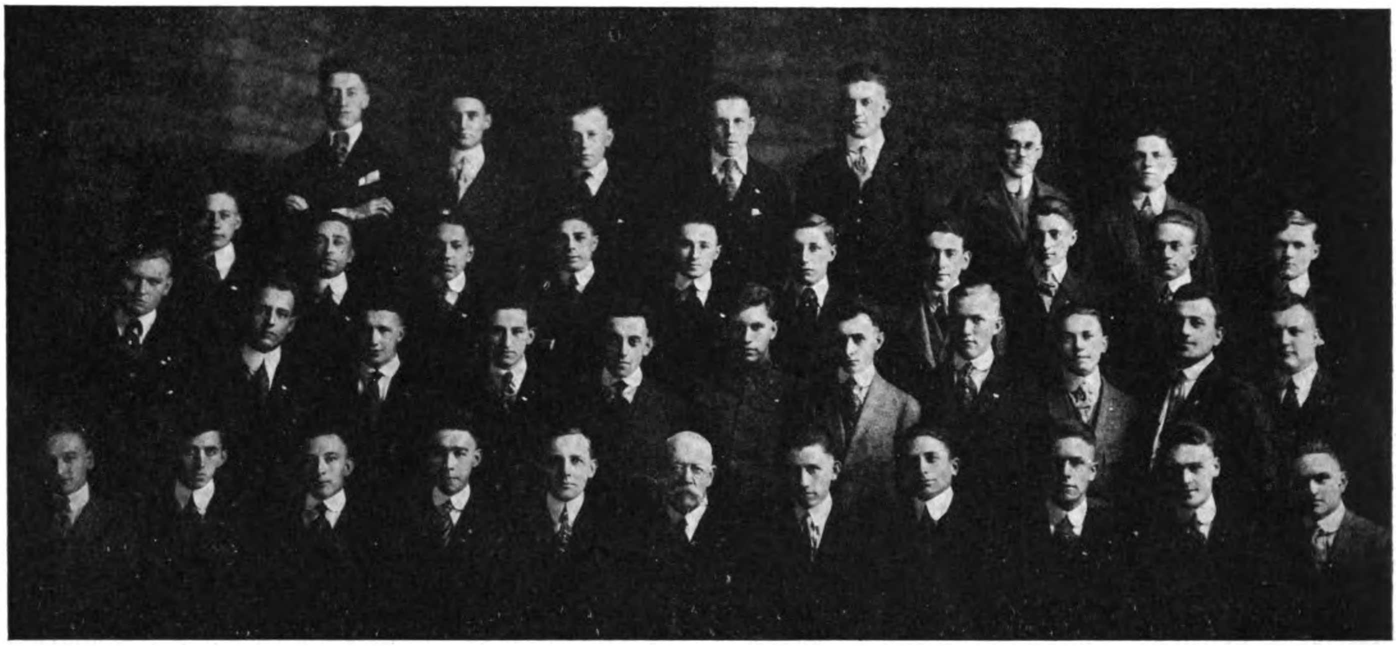
Wave Length	Nearest Usable Wave Length	Per Cent Change
10,000 m.	9,100 m.	9.0
300	299.1	0.3
200	199.6	0.2
100	99.9	0.1

Consequently we reach the astonishing conclusion that under conditions comparable to those mentioned previously, *amateur stations (using sustained wave transmitters and beat receivers) might be as many as 400 in number between 100 and 300 meters without interference!* It will be noticed that I have stretched the amateur wave length range to 300 meters, which is a change that I favor under the conditions mentioned, since interference would then be so markedly reduced.

Arc and Vacuum Tube Transmitters

I need hardly point out at length the desirability of having 400 stations in the same amateur zone working without interference as compared to a possible 10 under present conditions. The improvement speaks for itself.

It is necessary to go further, and point out the actual methods which will probably enable the amateur to carry out so admirable an improvement. To begin with, he will need for his transmitter a sustained wave generator of extremely constant frequency or wave length. Also, it should be steady and silent in operation. Although I have repeatedly drawn 10 or 20 watts at 200 meters from small Poulsen arcs on 220 volts direct current by a simple enough method, I cannot recommend the arc for the desired purpose. It is not sufficiently constant in either wave length or current output for the purpose. It may be possible to improve it eventually, but, so far as I know, it is not a very satisfactory device at 100 or 200 meters.



Hundreds of students similar to this radio and buzzer class at the St. Louis University are being prepared, at the various schools throughout the country, to operate the new devices in wireless telegraphy and telephony developed during the period of the war

It is probable that Chaffee arc sets somewhat like those described by Mr. Bowden Washington in the August, 1916, issue of the Proceedings of the Institute of Radio Engineers would be satisfactory for the purpose if the "inverse spark frequency" were painstakingly and accurately adjusted. I regard this as a highly profitable direction for investigation since the Chaffee arc is a simple and reliable device, and is well suited to amateur purposes. In its most recent forms, with the hydrogen tanks eliminated and alcohol vapor substituted, it seems to be remarkably well adapted to work from 100 to 300 meters with a steady sustained wave, suited to beat reception. I recommend experimentation and perservering tests with this most promising device. In working with it, attempts should be made to keep the running voltage as low as possible.

If one is content with low power and somewhat unusual equipment, the large vacuum tubes form an alternative source of steady oscillations of constant wave length. It is not excessively difficult to cause such bulbs to produce oscillations corresponding to 200 meter waves, particularly if high vacuum bulbs

are used. It is to be hoped that these bulbs will be produced for the amateur market in form suited for both filament lighting and electron current supply from ordinary 110 volt D.C. power lines. That is, either a long 110 volt filament or a low voltage filament with series resistance should be used. Furthermore, the 110 volt supply should be also used in the plate circuit either directly or with a potentiometer. This double use of the 110 volt supply is quite possible, and has indeed been already accomplished by one of the best versed experimenters with such bulbs. The simplicity of such an arrangement is considerable, since one needs merely plug into any 110 volt socket to start the outfit operating. If alternating current only is available, rectifiers of some sort (e.g., hot filament vacuum rectifiers of the Fleming valve or kenotron types) become necessary.

Avoiding Capacity Changes in Tubes

At least one advantage in the use of the vacuum tube for transmitter is that the same bulb with a slight change can be used for the receiver. There should be simultaneous power reduction and wave length change by means of quick-acting switches. In this connection, an increasingly well-known difficulty with very short wave beat receivers may be mentioned. Particularly, when using the vacuum tube in beat receivers, the capacity in the various circuits at 200 meters is extremely small, and may be only the internal capacity of the tube itself. Consequently bringing the hand near any unshielded condenser causes a huge percentage change in capacity because of the capacity of the body, and the tuning (which is extremely close and delicate at best) is completely thrown out. It will almost certainly be necessary for really reliable operation to enclose the entire receiver, and for that matter the transmitter also, in a grounded wire netting screen. Any handles for adjustment must come through small holes in this screen or else be operated by means of soft iron attachments on the handle and small permanent magnets outside the screen.

There is a curious type of interference which will arise when two sustained wave amateur stations get too close together in wave length. It is familiar to those who have occasionally heard Nauen on 12,800 meters interfere with South San Francisco, the latter being also a sustained wave station. This is "beat interference," and results in the clear beat tone being heard whenever the waves from both the interfering stations come in. It is an annoying form of interference but can be avoided among amateurs with very slight trouble.

The Field for the Amateur Radiophone

Another great advantage of the sustained wave transmitters which I have been advocating for all amateurs is that their long-desired goal of radio telephony becomes immediately accessible. All that is necessary is an ordinary telephone transmitter placed in the antenna, for example, with Chaffee arc sets or vacuum tubes; or used as a trigger control in any one of a number of interesting ways with the tube oscillator. I need not dwell on the additional value to the amateur of a combined radiophone and radio telegraph set, which is exactly what these sustained wave transmitters practically are. When used for radio telephony ordinary detector reception is possible, and in some ways preferable, to beat reception. Even supposing that these stations are received on ordinary crystal or vacuum tube detectors, there can be as many as 40 operating simultaneously without interference between 100 and 300 meters. Furthermore, they will not interfere at all with the hundreds of other sustained wave, beat received radio telegraph stations in the same zone.

How Spark Sets Handicap Sustained Waves

There is one matter of the utmost gravity in connection with the suggested proposal of sustained wave telephone or telegraph transmitters combined with beat receivers for amateurs. And that is the absolute necessity, if the desired results are fully to be achieved, of having *all* amateurs working in this fashion. Every old-fashioned spark transmitter in a given zone will render its 20 meter range of wave lengths practically unusable by the more modern and highly efficient sets. So that only a few amateurs of the older type in any given zone would practically wreck all good work, even if they had the best intentions, which latter might not even be the case. It would be the intrinsic clumsiness of their apparatus which would be to blame, exactly as would be the case in a musical competition between a violin and an automatic rivetter.

Removing the "Jamming" Bugbear

Since this is therefore a great advance, calling for the simultaneous co-operation of *all* amateurs, I suggest most earnestly that leading and influential amateur organizations, begin an educational and legislative campaign in this direction. It would be well to appoint a *Committee on Amateur Stations*, the duty of which Committee should be the spreading of the most modern and advanced ideas as to station construction and operation. Needless to say, the paramount function of this Committee would be to prepare the way for the great forward step to sustained wave transmitters and beat receivers. The publishing of suitable literature explaining simple, practical ways of getting the desired results can be to great advantage left to such a Committee. Furthermore, the drawing up of a program for suggested legislation along these directions and the enlisting of amateur and public support for such measures would also be a function of the Committee.

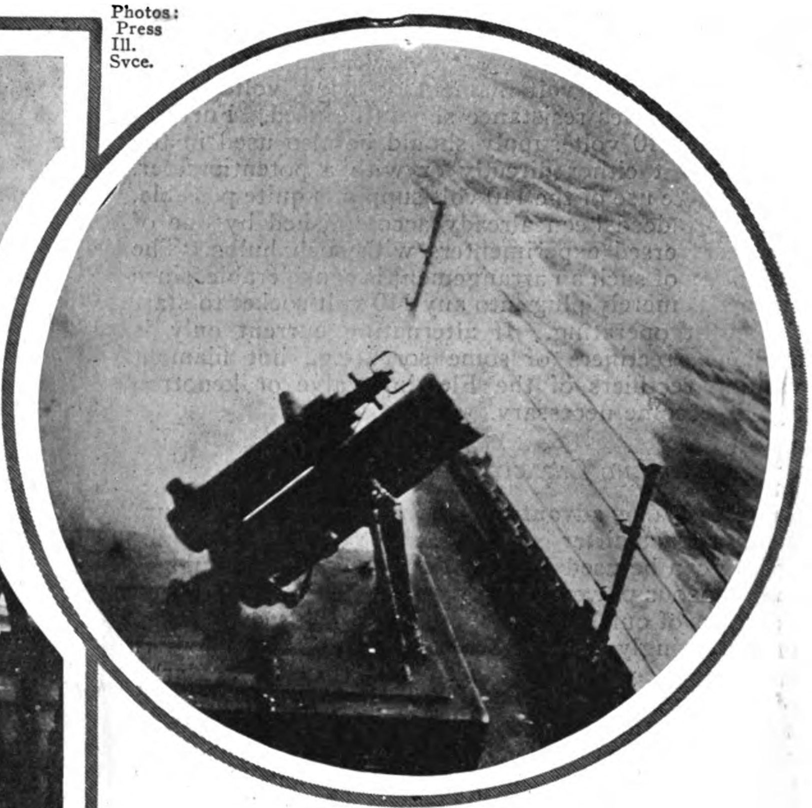
In this way, every amateur would be given much widened opportunities, and the advanced worker would be protected. Furthermore, even the beginner would be much assisted by the removal of the bugbear of everlasting "jamming." A campaign for the new type of amateur sets would therefore be a direct contribution to the spread of scientific knowledge over the entire country and an increase in public interest in the radio field. I need hardly say that this is the most basic and fundamental type of real national preparedness, and that no greater stimulus to national progress exists than awakened interest in science and scientific methods.

Suggestion for Prize Contest April Wireless Age

We will pay the usual prizes of $10, $5 and $3, in addition to our regular space rates, to the three contributors who send us the best manuscripts on the following subject:

What, in your opinion, is the most efficient receiving set for amateur wave lengths, and what should be the dimensions of the antenna and the tuning coils for best results?

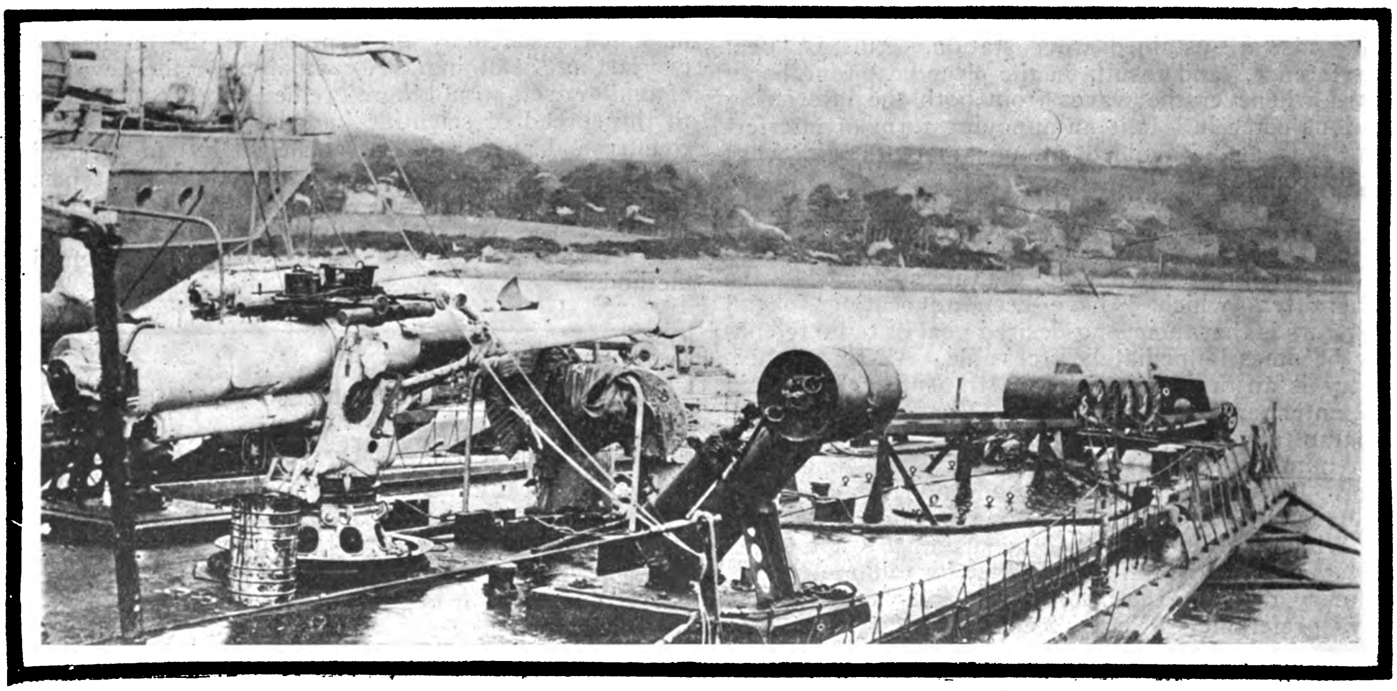
Photos: Press Ill. Svce.



"Ash Cans!"

The Depth Bombs Which Beat the Submarine

These photographs are the first which the Navy has released for publication showing the depth bombs which American gobs insistently termed "ash cans"—for the duration of the war. The view in the upper circle shows the depth mine gun in action; the surface view of the finish of a Hun submersible shortly afterward, appears on the left



Tranquillity graces this deck scene of an American fantail lying alongside the mother ship Melville, her mission accomplished. A depth charge is here resting on its gun; nearby is a rack capable of holding 44 additional "cans"

My Experiences in the War

First Installment of the Personal Narrative of a Pioneer in Aircraft Wireless Who Was Wounded and Captured In the Attempt to Stop the Hun Invasion

By Captain Gordon Adams

South Lancashire Regiment

Capt. Gordon Adams

DURING the first year after I had passed through the Royal Military College at Sandhurst, and obtained my commission as a Second Lieutenant in the English Royal Army, I found that the whole of my spare time was engaged in learning actual military work; but at the end of that period, in 1908, my regiment moved to a small village in Ireland, and having successfully passed my examinations for promotion to the rank of Lieutenant, I had a considerable amount of time at my disposal for working at subjects other than of a pure military nature. From this time on, I devoted every possible moment that I could spare from my military duties to the study and application of mathematical science.

Starting off with astronomy, I went all through the subject of navigation, both theoretical and, as far as possible, practicable. This led on to surveying, and so on to optics and mathematical physics in general. Every new field that opened up demanded an increased knowledge of mathematics and I, therefore, had to work away solidly at that which is the absolutely indispensable tool in the tackling of any branch of science.

In 1910, I was made musket instructor to my regiment. Then I found numerous opportunities for applying the knowledge which I was gaining in addition to my professional duties. During my annual leave I made up the practical part which I was unable to work at while with my regiment through lack of instruments and other facilities. On these occasions I generally managed to get what I wanted in London or Cambridge Universities.

In May, 1912, the British Government decided to create the Royal Flying Corps, consisting of a Naval and a Military wing; in the autumn of that year the Central Flying School was inaugurated for the training of Naval and Military airplane pilots. Early in 1913 I sent in an application to join the R. F. C. and was very fortunate in having my application accepted within a very short time.

In those days the government required all officers to take their Royal Aero Club certificate at their own expense at a civilian flying school before proceeding to the Central Flying School. Once accepted as a Military Pilot, however, expenses were refunded. There were four flying instruction grounds then in existence. I selected Hendon (Brooklands, Eastbourne and Salisbury Plain being the other three). At Hendon there were four main schools, the Graham-White, the Bleriot, the Caudron and the Deperdussin. I chose the Caudron. The Caudron machine was a single seater tractor, with a 35 h.p., Y-type Anzani engine. It had no ailerons, the lateral control being effected by wing warping. It was unique in its construction; for though a tractor machine it was built with tail booms exactly like a machine of the pusher type. The pilot sat in what looked like a small cockle shell.

In the Caudron School, as in all other schools using single seater machines, the instruction was of the "Fly or Die" type. You were given a machine, and after a few explanations as to what to do, you were told to "push off" and taxi the machine about the ground, but after acquiring more confidence the throttle was opened until flying speed was reached; then a small drop was executed which usually terminated in a somewhat abrupt "alterissage." These hops were gradually lengthened until the pupil was able to make an ordinary straight flight.

When I did my first drop, I had never been up as a passenger, so that it was the first time I had ever lost touch with the earth. There is no question that the sensation embraced, for me, more than mere novelty. From straight flights the pupils went on to turns, until eventually the standard required for the R. Ae. Club's certificate was reached. The test for this certificate was to fly 5 figures of eight at a height of not less than 150 feet, and then to land. After touching the ground, with the engine switched off, the machine had to come to a standstill at a distance not greater than 50 yards from a given point. This performance had to be gone through twice.

Owing to the instability of machines in those days, no instructional flying was carried out except when the weather was absolutely dead calm. This entailed getting up in the morning at dawn, the hour when the air is usually calmest.

On the morning I was going to take my Aero Club certificate I started off full of confidence, but after doing a half-circuit of the Aerodrome, and when I was only about 15 feet off the ground, my engine began to miss badly. I found myself up against the proposition of either charging straight into a shed or attempting to turn. I tried the latter, sideslipped and crashed. . . .

No other machine being available for me to have another try on, I had to wait until my arrival at the Central Flying School to take my "ticket."

Just as the training methods were widely different from those of the present day, so did the early aeroplanes reflect the inefficiency of aeronautics five years ago. The equipment available for flying instruction was uncertain and diversified. In addition to the schools at Hendon there were several manufacturing firms experimenting with different types of machines. One of these was the Breguet. This machine was peculiar in many ways. In the first place, most of the spars were steel instead of wood. It had only one row of interplane struts, and when stationary the trailing edges of the wings were very flexible and hung down in festoons. The wings were warped for lateral control by the feet, the steering being done by a wheel. The tail and rudder were two flat planes fixed at right angles to each other, the whole being attached to the end of the fuselage by a universal joint. The result was that the tail or elevator and the rudder could not be

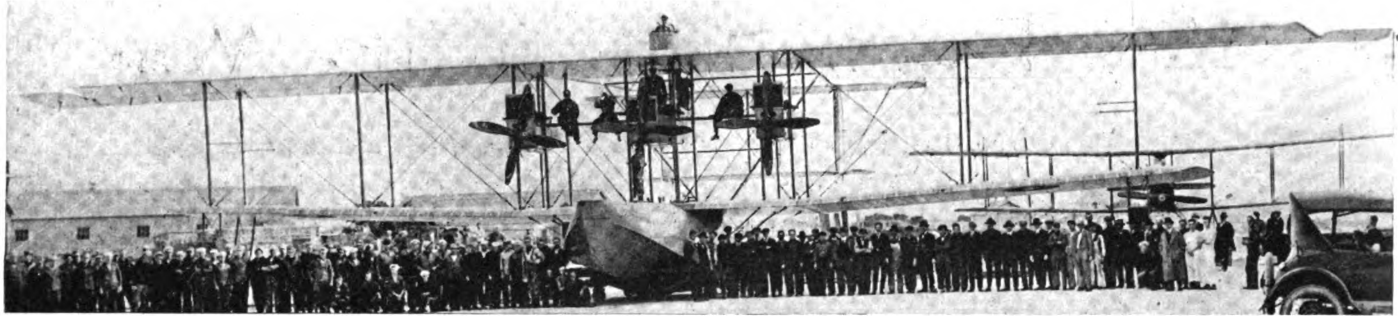


Photo by Int'l

This giant American hydroplane, which carried fifty passengers in a flight at Rockaway Beach, N. Y., offers a striking contrast to the early machines which Capt. Adams describes. It is propelled by three Liberty motors developing twelve hundred horsepower and producing a speed of eighty miles per hour

moved independently of one another. On one occasion when a Frenchman named Collardeau was flying the machine, the universal joint gave way and the whole contraption fell off in the air.

But even then, a lively discussion was being carried on about attempts to fly the Atlantic. Lieutenant Porte, I recall, was at Hendon at that time flying a 100 h.p. Anzani-motored Deperdussin, which was expected to casually cross the Pond most any day.

Another company at Hendon was the Handley-Page. They had one shed and were experimenting with a monoplane, with indifferent success. The future could not then be foretold, but I was certainly very pleased when Mr. Handley-Page made good on his bombing machines, for he persisted through many years of bad luck.

Gustav Hamel was another generally to be seen performing what then appeared to be the most astounding aerobatics. He generally flew a Bleriot monoplane with a Gnome engine, but later took to a Morane-Saulnier monoplane with a Le Rhone engine. Beatty was also frequently in evidence on an odd twin-propeller Wright machine.

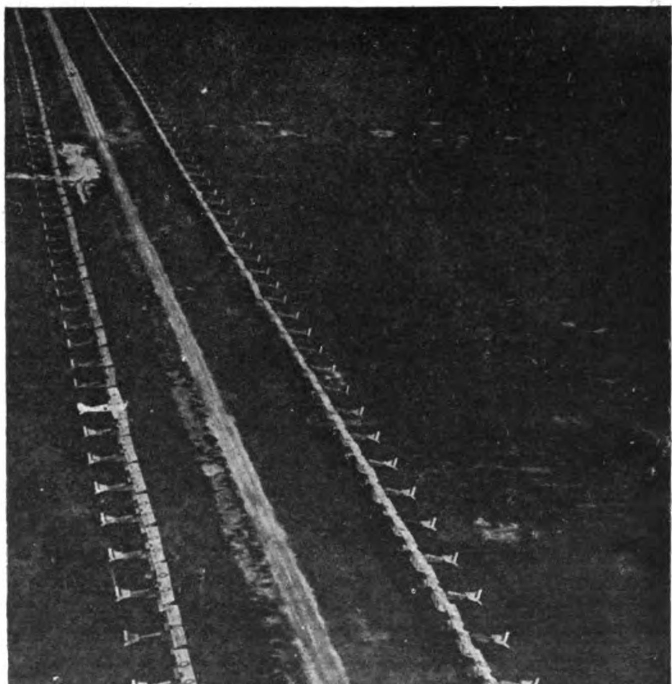


Photo by Int'l.

View of the flying field and its equipment of over 100 airplanes at Ellington Field, Houston, Texas. Contrasted with the flying fields described by Capt. Adams, some impression is gained of the rapid development of the airplane in the last five years

When I arrived at the Central Flying School, I was given a Short biplane with a 70 h.p. Gnome engine. It was one of the old box-kite types in which pilot and passenger sat side by side. The ailerons were of the non-balanced type; that is, owing to the absence of a balancing wire they hung straight down when the machine was stationary. The speed of the machine was somewhere about 40 miles an hour. I took my ticket on this machine about a week after I arived at the C. F. S.

The school was organized into 4 flights, A, B, C and D, and the pupils, who were both naval and military officers, were divided up amongst them. About half way through the three months course, the pupils were changed to other flights, so that on graduation each officer had flown at least two types of machine, generally one tractor and one pusher. A flight was equipped with Avros; B, with Maurice Farmans; C, with B.E. 2's; and D, with Henri Farmans and Shorts. In addition to actual flying the course entailed searching examinations on theory of flight, construction, rigging, engines, theoretical and practical meteorology, formation of troops, cross-country navigation, use of maps, and types of British and foreign war vessels.

Much of the engine instruction was devoted to the Gnome, which was the original rotary engine. It had seven cylinders. The exhaust valves were in the cylinder heads and opened direct into the air and the inlet valves were in the piston heads, the gas coming in through the crank case. There were, therefore, neither intake nor exhaust pipes.

I took my civilian pilot's certificate in May, 1913, and graduated at the Central Flying School as a military pilot in August. From then I joined No. 5 Squadron, R. F. C., at Farnborough.

The establishment of the military wing of the R. F. C. in those days was one squadron of airships and seven squadrons of airplanes. The whole was commanded by Lt. Col. F. H. Sykes. Each squadron of airplanes consisted of three flights. Each flight consisted of one Flight Commander, ranking as a Captain, and three flying officers ranking as Lieutenants or Second Lieutenants, and was equipped with 4 machines. The total officer personnel of a squadron was, 1 Major in command, 3 Captains and 15 Lieutenants or Second Lieutenants, six of whom acted as observers. All officers had to be pilots; equipment officers had not then come into being. The technical and routine work which nowadays is done by equipment officers was then carried out by the pilots themselves. The larger units such as wings, brigades and divisions were non-existent.

This establishment was only partially completed when I joined the corps, in fact there were only four airplane squadrons in existence and they were not completely equipped. The whole corps at that time was naturally in a very embryonic stage. My squadron had in it no fewer than seven different types of machines. These were:

The Maurice Farman "Longhorn," with 70 h.p. Renault V-type engine.

The Henri Farman with 80 h.p. Gnome engine. (These were both of the pusher type, the main difference being that the M. F. had a front elevator, whereas the H. F. had not.)

The single seater Avro, with 50 h.p. Gnome engine.

The Sopwith, with 80 h.p. Gnome engine.

The Caudron, with 45 h.p. Anzani engine.

The B.E. 2a, with 70 h.p. Renault engine.

The Graham-White, with 45 h.p. Anzani engine.

This last named machine was a quaint looking device and was popularly known as the "Pterodactyl." The fuselage projected some distance in front of the main planes and it was there that the observer sat with the engine immediately in front of him.

My flight was equipped with Avros. They were sporting machines to fly as they had, virtually speaking, no lateral control at all. The wings were supposed to warp, but as the warping cables were led up from the base of the first struts to the top of the second pair, very little bending of the wing tip could be obtained. In fact it had absolutely no effect at all! All lateral control had to be done with the rudder.

The B.E. 2 was another wing-warping machine, but in this case the warping cables were led straight from the fuselage to the top of the outer rear struts. This gave it twice the warping effect of the Avro. It was a very uncomfortable machine to fly on a rough day, as the wings were very flexible and frequently a gust under one wing would cause the wing to warp suddenly, which, acting through the control cables, would in many cases jerk the joystick out of the pilot's hands and give him a sharp blow on the inside of his knees. This machine was the forerunner of the numerous B.E. types.

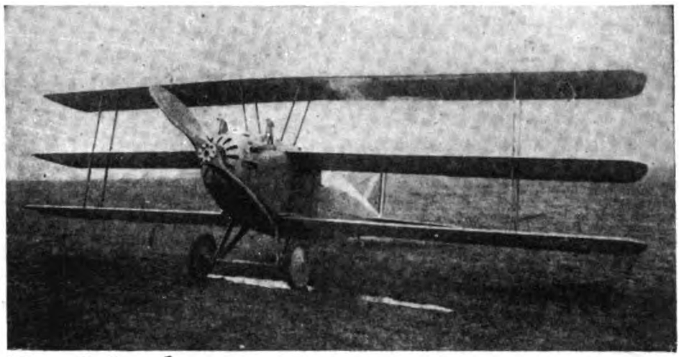


Photo: Int'l

The world's fastest airplane, built by Curtiss. Carrying a full military load it attained a speed of 160 miles per hour and climbed 13,000 feet in ten minutes. The 'bus in which the author learned to fly five years ago had less than one-fifth its power and one-quarter its speed. The triplane illustrated has a new 400 horsepower K-12 engine, which is lighter by 25 per cent than any other aeronautical engine

Photo: Central News

The ease with which wireless communication is held with aircraft records some rapid progress since the writer of this article began to apply wireless to the airplanes of the British Royal Flying Corps

The corps at that time only consisted of about 60 officers, of whom 90 per cent were regulars, seconded or loaned to the R. F. C. from their respective regiments. It was a great life in those days, flying machines which viewed from the present day standpoint appear absolutely prehistoric.

I spent about four pleasant months doing practically nothing but flying. Then I began to feel that I wanted to progress. So I obtained leave and went up to London University and, metaphorically taking my coat off, got down to real hard work on theory and practice of wireless telegraphy with a view to applying it to aviation.

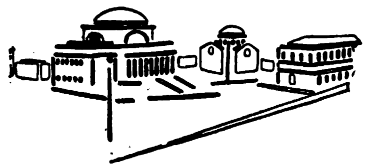
On the termination of this period of leave I returned to my squadron, and within a week an experimental flight was started consisting of eight officers. Great assistance was given by the Royal Engineers at Aldershot; they loaned the observatory and wireless station to the corps for experimental purposes. The particular job that I was detailed to was the theory and design of wireless installation on airplanes. The first installation was a Rouzet set, and it was upon this crude equipment as a start that the present day airplane wireless was built.

It would give great amusement to pilots of today could they see those old B.E.2 machines which we used for wireless experimental work. The fabric in many cases had to be removed from the wings in order that yards of wiring might be run round the edges of the planes to supply additional capacity.

As a start, the only thing attempted was to transmit messages from the machine at a low altitude to a station on the ground, but before the war broke out two machines had actually got into communication with each other in the air at a distance apart of about ten miles. In addition to myself, there were three other officers engaged on wireless work. All three are dead now, two were killed in the air, and the other died from illness. These three officers did all the practical flying work while I was mainly concerned with the solution of any mathematical problems which they presented to me, such as calculating the curve which a trailing wire aerial would take up at a given speed in order to see if it would clear the undercarriage while being unreeled, and similar problems. The trailing wire was the only type of aerial used, though suggestions were frequently forthcoming for draping aerials between the wing struts regardless of the additional wind resistance which they would cause.

(To be continued)

Progress In Radio Science



The Production of Tone Frequencies

METHODS of operating a wireless system over a wide range of tone frequencies devised by Oscar Roos are shown in the diagrams, figures 1 to 6.

The fundamental circuit is shown in figure 1. A condenser C-2 is connected in series with an inductance L-2 and a radio frequency alternator A-2, for which may be substituted, if desired, an arc generator of the Poulsen type. A spark gap S is included in the circuit, which may be placed in the field of a magnet M or in a vessel containing a compressed gas. Two trigger valves or arresters V and V-1 are connected on either side of the spark gap. These arresters may be an ordinary spark gap, a quenched spark gap, or two oppositely arranged rectifiers such as a point and plate

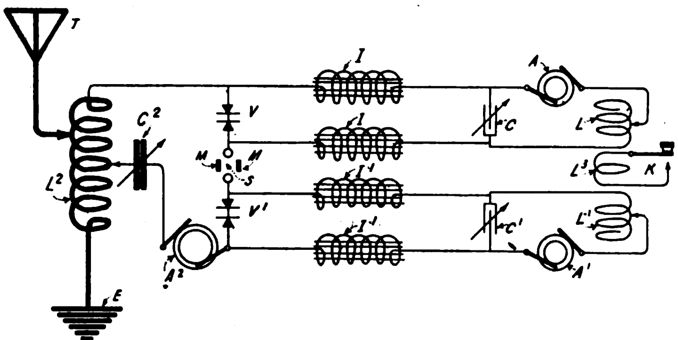


Figure 1—The fundamental circuit of the Roos wireless system for wide range of tone frequencies

rectifier, a hot and cold electrode rectifier, a mercury vapor rectifier or an aluminum or other film arrester. These arresters normally prevent the condenser C from discharging across the spark gap, but they are rendered ineffective through being broken down momentarily by an impulse from an auxiliary source, which in this case consists of two low voltage alternating current generators A and A-1 of different frequencies. Generator A is connected in series with inductance L and condenser C and generator A′ in series with inductance L′ and condenser C-1.

Coils L and L-1 are placed in inductive relation by means of the linking system L-3 which includes the key K. By closing key K the circuits L, C and L-1, C-1 are thrown into resonance and the potential resulting therefrom breaks down the arresters V and V-1, thereby rendering the spark gap operative. If the frequency of the alternators A and A-1 are within the range of audio tones, the amplitude of the antenna oscillations will vary periodically accordingly.

A modification is shown in figures 2 and 3 where the condenser is charged by a direct current generator G, which is protected by the choke coils I and I-1. It is connected in series with the quenched spark gap S′.

In operation neither the high frequency generators A-1 or A-2 or the dynamo G can break down a larger gap than S-1 and S-2 and the arresters, therefore, prevent the discharge of the condenser C-2 across the gap unless they are simultaneously broken down. If n represents the frequency of generator and m the frequency of generator A-1, the arresters will be simul-

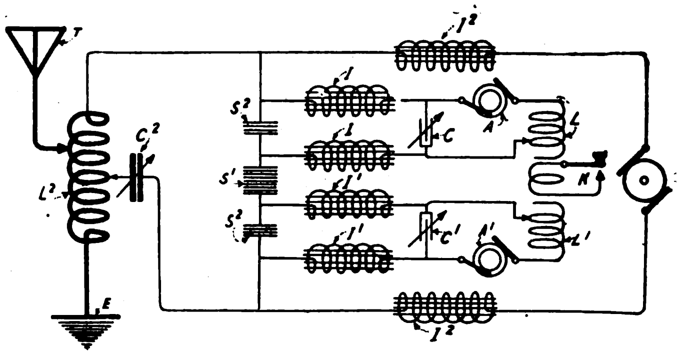


Figure 2—Modified circuit with a direct current generator, protected by choke coils, charging the condenser

taneously broken down 2 (n—m) times per second and the tone produced in the receiving system will be the beat frequency of the generators. It is obvious that this tone may be varied over a great range by slightly altering the speed of one or both of the generators. The design of the dynamo G is such that it will have a falling voltage characteristic in order to prevent arcing in the spark gap. Figure 3 differs from 2 in that rectifiers are employed as arresters in place of the quench gaps S-2 shown in figure 2.

The modified circuit in figure 4 has the auxiliary source of energy for discharging the main circuit, coupled to two alternators A and A-1 connected in series. By means of the valve connection V-2 both halves of the wave are rectified. By means of the transformers M and M-1 the energy of the resulting unidirectional impulses is impressed as two alternating currents having twice the frequency of the generators, respectively upon the circuit which includes the condenser C and the direct turn generator G. The generator normally cannot break down a larger gap than S, S-1 and the arresters therefore prevent the discharge

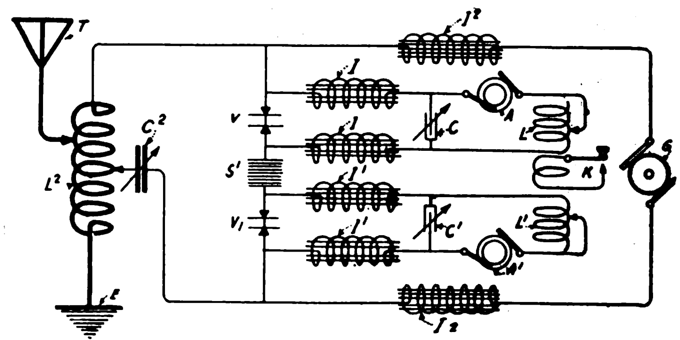


Figure 3—Showing circuit with rectifiers employed as arresters in place of quenched spark gaps

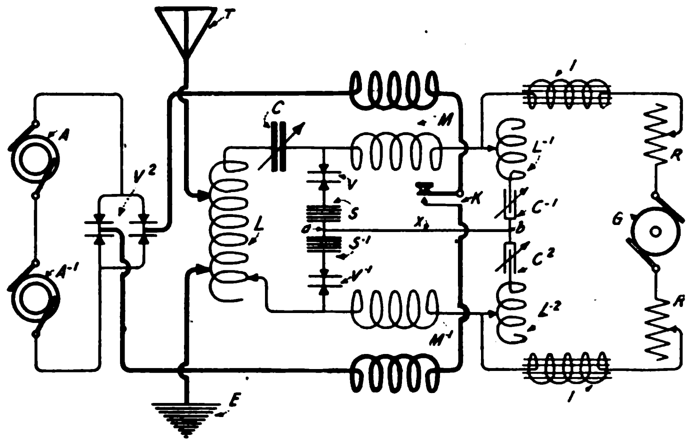


Figure 4—Diagram of connections, showing the auxiliary source of energy for discharging the main circuit, coupled to two alternators connected in series

of condenser C unless they are broken down simultaneously. They will be broken down simultaneously 4 (n—m) times per second where n and m represent the frequencies of the generators A and A-1. The tone produced in the receiving system will be the beat frequency of the alternating current developed, as mentioned before, in the secondaries of the transformers M and M-1 and this tone may be widely varied by slightly altering the speed of one or both of the generators.

The advantage of connecting the generators in series is, that the maximum beat voltage which is always the sum of the voltages of the two machines is much higher for a given beat frequency than that which other things being equal would be obtained from a single machine developing currents of the given frequency.

For example, if the normal or full-speed frequency of the generators is 8,000, then by reducing the speed of one of them so that its frequency is 4,000, the beat frequency will be 4,000 and the total voltage will be the sum of the full-speed voltage of one machine plus the half-speed voltage of the other, or 300% higher than the voltage of either machine running alone at 4,000 cycles. If, however, the beat frequency is much lower the advantage of the serial connection of the generators is more striking. For example, if the frequency of one machine is 8,000 and that of the other 7,500, the beat frequency will be 500, which corresponds to 1/16 full speed, while the total voltage is 31/32 the full voltage of both machines. Either machine running alone at 500 cycles would generate only 1/16 its normal or full speed voltage of 1/31, the voltage obtained by the Roos arrangement.

The generator G is protected from the currents of alternating current generators A and A-1 by a shunt

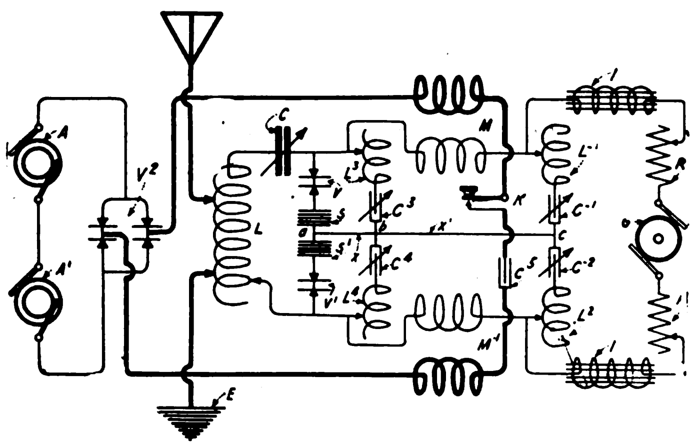


Figure 5—Circuit to augment the effect of the auxiliary source by sharper resonance

having negligible reactance for the beat frequency. This is connected across the terminals of the generator as in figure 4.

The shunt consists of a circuit L-1, C-1, B-2, L-2 which is tuned to the beat frequency of the alternating currents developed in the secondaries of the transformers M, M-1. This circuit consists of two serially connected branches, one branch C-2, L-2 being tuned to a frequency higher than the beat frequency and the other branch C-1, L-1 to a frequency lower than the beat frequency. The complete circuit L-1, C-1, C-2, L-2 being tuned to the beat frequency, it follows that this circuit has negligible reactance for currents of that frequency, and that the potential drop across the terminal of the circuit is practically nothing. Choke coils I, may be employed to protect the generator G from the effects of the oscillations developed by the discharge of the condenser C across the spark gap.

Because one branch L-2, C-2 is tuned to a frequency higher than the beat frequency and has capacity reactance, and the other branch L-1, C-1 is tuned to a frequency lower than the beat frequency and has induct-

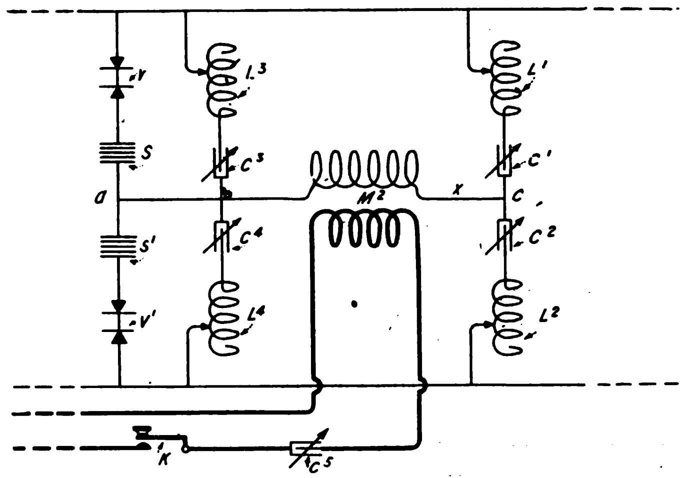


Figure 6—Detail of figure 5 indicating the association of the auxiliary source circuits with the transformer without change in mode of operation

ance reactance, the passage of the beat frequency current through the circuit L-1, C-1, C-2, L-2, L, C, will develop a high potential difference between the terminals of the arresters V, V-1 respectively. They break down simultaneously and permit the condenser C to discharge across the gaps S, S-1.

It will thus be seen that the system shown in figure 4 meets the contradictory requirements of low beat frequency voltage across the choke coils I, I, for the protection of the generator G and high beat frequency voltage across the arresters for momentarily breaking them down and rendering them ineffective.

To augment the effect of the auxiliary source by sharper resonance the high impedance of the radio frequency circuit C, L is eliminated for currents of beat frequencies by using the arrangement shown in figures 5 and 6, in which a second circuit L-3, C-3, C-4, L-4 tuned to the beat frequency, is connected across the system. This circuit consists of the branch L-3, C-3 tuned to a frequency higher than the beat frequency and the branch C-4, L-4 tuned to a frequency lower than the beat frequency.

The branches L-3, C-3 and C-2, L-2 are both tuned to the same frequency and branches L-4, C-4 and C-1, L-1 are both tuned to the same but lower frequency, so that the circuits L-4, C-4, X-1, C-2, L-2 and L-3, C-3, X-1, C-1, L-1 are each tuned to the beat frequency. The secondaries of the transformers M, M-1 are so

connected that the beat frequency currents will flow in the last named circuits and have a common direction in the conductor X-1, thereby avoiding the radio frequency circuit C, L which has a high impedance for this current. These currents are amplified by resonance.

As indicated in figure 6, the circuit of the auxiliary source may be associated with the transformer M-2 or otherwise with the branch X-1 without changing the mode of operation. A transmitting key may be connected in the circuit of the auxiliary source or otherwise associated with the system.

Rouzet Transmitting System for Increasing Spark Frequencies

A SYSTEM of obtaining high spark discharge frequencies from oscillation circuits excited by a three phase low frequency generator, has been devised by Lucien Rouzet of Paris. M. Rouzet mentions one of the advantages of employing multi-phase current is that the generator is kept on load during transmission and the output is therefore more steady than in a single phase system. An objection to the use of a single phase high frequency generator is that it requires a low self induction which increases the problem

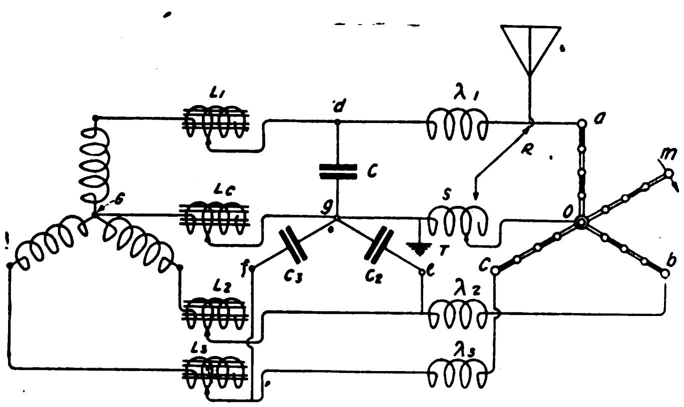


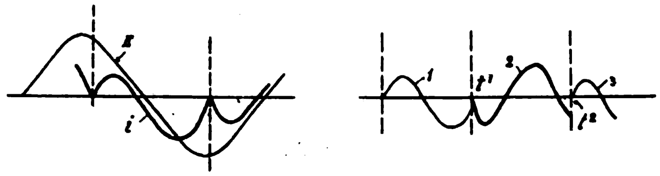
Figure 1—Fundamental wiring diagram of the Rouzet transmitting system for increasing spark frequencies

of design. Furthermore in high frequency systems the time of the charging period is reduced as the frequency is increased, but the discharge period, whether for low or high frequencies, remains the same. On the other hand in systems employing charging currents of low frequency the period of discharge is short compared with the period of charging which increases the efficiency considerably, principally because it reduces the short circuit current which generally occurs while the condenser is discharging across the spark gap.

To show the increase in amplitude of the radio frequency currents generated by the Rouzet system, as compared with the single phase high frequency system, the curves of figures 2, 3 and 4 are shown. Figures 2 and 3 indicate the relative amplitude to be expected from a single phase system, in which the spark discharges synchronously, that is, twice per cycle. Figure 4 indicates the amplitude in the three phases of a three phase system as well as in the neutral wire.

The fundamental wiring diagram in figure 1 shows a star-connected three phase source of current G, which may be a multi-phase alternator or the secondary winding of a high potential three phase transformer. As will be seen each phase feeds a condenser, the three condensers C-1, C-2, and C-3, being star connected. Their neutral point G is connected to the neutral wire. The charging circuit is further made resonant by means of the inductances L-1, L-2, L-3, and L-c.

The rotary spark gap contains three sets of stationary electrodes, A, B, and C, and a rotating member, M, which is so designed that when OM is in the position OA, OB or OC, four spark discharges in series take place and the condensers are discharged successively in resonance with the charging current.



Figures 2 and 3—Graphic curve showing the relative amplitude to be expected from a single phase system

If the rotating arm of the spark gap revolves at a rate of two revolutions for each charging period, two discharges per period will be obtained in each phase, giving a total of 6 discharges per revolution. In order to maintain identical periods of oscillation in each discharge circuit, inductances are inserted in each branch.

In summary, each condenser with its particular phase acts as a single phase system, but the total number of discharges will be three times that of a single phase system or, in other words, the spark frequency is increased. By proper adjustment of the rotary spark gap, the spark can be made to take place when the charging current passes through a zero value, thereby preventing arcing; but this can only be accomplished when the charging circuit is properly tuned itself.

Figure 4 shows the super-position of the curves i_1, i_2 and i_3 of the stages of a three phase star-connected system. The sum of the currents passing through the neutral wire is represented by the curve I_0. In such a system this curve is of the regular shape and the current varies with a frequency equal to the threefold frequency of the phase voltage.

The antenna oscillation transformer is included between the points G and O and in this case is of the conductively coupled type. Inductive coupling, may, however, be employed.

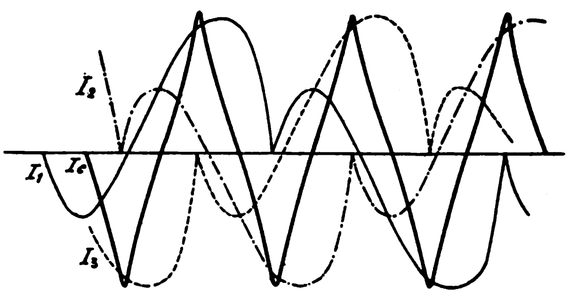


Figure 4—Graphic chart indicating the amplitude in the three phases of a three phase system

Magnetic Modulating System for Wireless Telephony

IN wireless telephony, if the carrier or high frequency currents are modulated by varying the permeability of a radio frequency transformer with an iron core, the speech signals are distorted by hysteresis in the iron. There has been devised by Ralph V. L. Hartley, of New York, a modulating system of the type mentioned, wherein the hysteresis effects are considerably reduced and the quality of the speech signals improved accordingly. It has been found also that a reduction of hysteresis improves the sensitiveness of the modulator. The factor of sensitiveness is defined by Mr. Hartley as the ratio of the modulated high fre-

quency power to the low frequency power affecting the modulation.

One way in which the desired modulation is effected by this invention is by subjecting the magnetic core to a relatively weak and rapidly alternating cross magnetization, which keeps the molecules of the iron in a constant state of agitation and renders them more

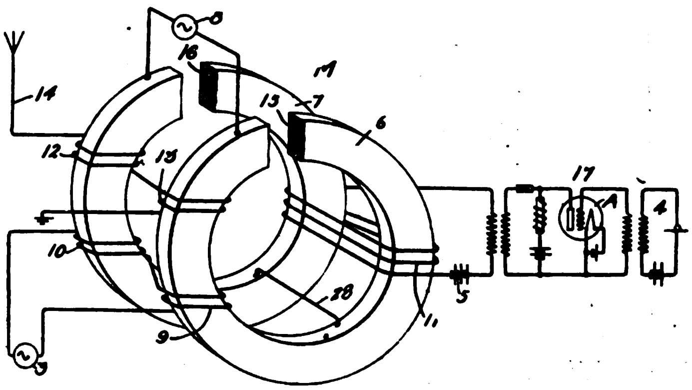


Figure 1—Design of apparatus for the magnetic modulating system of wireless telephony

susceptible to changes in the longitudinal magnetization produced by the currents of speech frequency. Figure 1 illustrates the preferred form of design in which the winding for the reduction of hysteresis is placed at right angles to the signaling and carrier frequency windings. Figure 2 illustrates a modification in which the carrier current windings are at right angles to the remaining winding. Figure 3 shows the details of the magnetic core construction.

In figure 1 the modulator M, which is of the magnetic type, is supplied with radio frequency currents from the source 3, which are to be modulated by speech currents supplied by the signaling circuit 4. The battery 5 supplies a steady current which brings the magnetization of the toroidal cores 6 and 7 to the desired point about which the magnetization is varied by the signaling currents. The source 8 supplies currents of a frequency higher than the carrier frequency supplied by the source 3 for the purpose of reducing the hysteresis. The circuit of source 8 may be traced from the source through the turns of coil 16 in series to conductor 28, through the turns of coil 15 in series, back to source 8.

The carrier source 3 supplies currents to the primary windings 9 and 10, which are individual to each of the cores 6 and 7, and which produce high frequency fluxes in opposite directions in these cores so that the signaling winding 11, which is common to both cores, is substantially non-inductively related to the windings 9 and 10. The opposing high frequency fluxes induce a resultant zero carrier frequency electromotive force in the signaling winding 11. The secondary windings 12 and 13 are adapted to supply speech modulated carrier currents to the radiating antenna system 14. The windings 12 and 13 are wound in opposite directions and are individual to each of the cores 6 and 7.

In order to reduce the hysteresis in the magnetic cores 6 and 7, windings 15 and 16, disposed within the cores 6 and 7, are provided for producing a magnetic field which is at right angles to the magnetic field produced by signaling winding 11 and the windings 9, 10, 13 and 12. The windings 15 and 16 are supplied by the source 8 with comparatively weak and very rapidly alternating currents, which have a frequency which is higher than that supplied by the carrier source 3. The signaling current supplied by the circuit 4 may be amplified, if desired, by one or more amplifiers 17 of the vacuum tube type.

The cores 6 and 7 may be constructed as shown in figure 3, in which the halves of the cores 18 and 19, which are held in assembled position, are made of compressed iron dust, and are channeled to receive the winding.

In figure 2 the antenna circuit may be traced from antenna 14 through the turns of the secondary winding 22 in series to ground at 29. The carrier current sources 3 is connected in series with primary winding 21. Windings 21 and 22 are both disposed within magnetic core 23. The low frequency winding 24 is wound around the core 23 so that the high frequency carrier current windings 21 and 22 produce magnetic fields which are at right angles to that produced by the signaling winding 24. The signaling winding 24 is non-inductively related to the carrier frequency windings 21 and 22, and the signaling winding 24 will accordingly not have any carrier frequency currents induced therein. This relative disposition of the carrier frequency winding and the signaling winding reduces the distortion, as the molecules of the core are agitated by the magnetic field due to the carrier currents and are

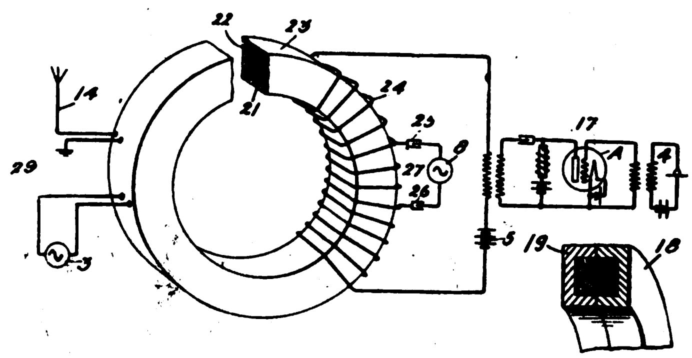


Figure 2—A modification showing the carrier current windings at right angles to remaining windings

Figure 3—Showing detail construction of the magnetic core

more readily susceptible to changes in the field due to the signaling current. To reduce the hysteresis loss due to the carrier frequency alternating field in the core 23, the source 8, supplying a frequency higher than the carrier frequency, in this case is connected through condensers 25 and 26 about a portion 27 of the signaling winding 24. The rapidly alternating magnetic field produced by the currents traversing the portion 27 of the winding 24 produces a field which is at right angles to the carrier frequency field so that the hysteresis is reduced, as in figure 1, by the high frequency cross-magnetizing field.

Winding Up the War

Photo Press Ill. Service.

That matters in Russia are still unsettled is reçalled by this glimpse of a frowning Japanese gun, above, in a test of fire control by wireless phone

The airplane shown at the left dropped a floral wreath as it flew over the Roosevelt home, a tribute to the dead ex-President who lost an aviator son in France

Photo by Int'l.

A remarkable picture of the President reviewing troops at the front. Watching the victorious Yankee boys go by are Generals Pershing, Liggett and Bullard. Mrs. Wilson is seated behind the President

Photo by Int'l.

The Monthly Service Bulletin of the

NATIONAL WIRELESS ASSOCIATION

Founded to promote the best interests of radio communication among wireless amateurs in America

A Plan for Organization

BEFORE the war there was a duplication of effort in amateur clubs and associations. With the re-opening day well in sight now, it appears that a discussion of better organization of the amateur field is a timely subject.

Organization of amateur interests by States seems the logical solution. State organizations have existed in the past, but in many cases the ends achieved were futile and the percentage of failure high. These failures were generally due to one or more of the following reasons:

1. Lack of funds
2. Insufficient power to control work of members
3. Jealousy between organizations
4. Rivalry between officers and directors
5. Insufficient co-relation between local clubs
6. Not close enough co-operation with State and National organization.

Platforms have not been broad enough. Either promotion of relaying or research work has been the dominating objective. These should be co-related and fostered simultaneously by a central agency.

Spasmodic bulletins and occasional circular letters have generally been the only means for directors to keep in touch with members. This method is inadequate.

The eventual solution should rest in a line-up something like this: Local clubs should maintain close co-operative relations with a State organization, as the basic unit to establish affiliation with a national body.

A member of each State unit should be elected to a national council to represent it in planning for the best interests of the amateur in questions of an inter-state nature.

State organizations should be controlled by a board of directors comprising five elected officers. The term of office should be one year, with re-election by general vote. The offices to be filled may be suggested as follows: President, Vice President, Secretary-Treasurer, Corresponding Secretary, Publicity Director. An important function of the Board's activities would be establishing close co-operation with Committee chairmen.

The following committees should be sufficient to cover all needs in the majority of States:

- Membership
- Affiliation
- Research and Development
- Interference
- Relay
- Publicity
- Meetings and Conventions

The function of most of these committees is evident from their names, but a few may need explanation. The affiliation committee's purpose would be rendering assistance to local clubs in their general activities, such as providing interesting papers and programs for their meetings (to take the place of the usual unprofitable disputes as to who does the most jamming), to give advice on financial problems and difficulties would be a necessary part of this committee's work, the members of which should become informed in the best methods of securing funds and stimulating club members' interest so they continue payment of dues.

The principal function of the interference committee would be to devise regulations for working in congested districts, arrange equitable divisions of time for operation where required, and to secure the earnest co-operation of federal officials through consistent effort to minimize or eliminate the evil of unnecessary interference. Adjustment of apparatus where the owners of stations are not willing or capable, might well become an important part of the field work of this committee. The effectiveness of this committee would, in large measure, be dependent upon the authority it would secure by loyal backing from the members. If a sufficient number would abide by the

(*Continued on Page* 35.)

**DEPARTMENT OF COMMERCE
BUREAU OF NAVIGATION
WASHINGTON**

December 20, 1918.

The Radio Laws and Regulations of the United States, edition July 27, 1914, are amended in the following respect:

Par. 122, page 63, amended this date, to read:

Amateur first grade: The applicant must have a sufficient knowledge of the adjustment and operation of the apparatus which he wishes to operate and of the regulations of the international convention and acts of Congress in so far as they relate to interference with other radio communication and impose certain duties on all grades of operators. The applicant must be able to transmit and receive Continental Morse at a speed sufficient to enable him to recognize distress calls or the official "keep-out" signals. A speed of at least ten words per minute (five letters to the word) must be attained.

Par. 126, page 64, amended this date, to read:

The code test shall continue for five minutes at a speed of 20 words, 12 words, and 10 words per minute, respectively, for the commercial first, second, and amateur first grade, 5 letters, numerals, or other characters to the word, and to qualify the applicant must receive 20, 12 and 10 words in consecutive order accurately and legibly written. Operators will not be permitted to break or interrupt while receiving or to correct or alter the transcription after it has been submitted to the examining officer.

You will note from the above amendments that it is the purpose of the Department to require future applicants for amateur first grade radio operator's license to qualify in the transmission and reception of Continental Morse code at the rate of ten words per minute instead of five as heretofore.

**Respectfully,
E. T. Chamberlain,
Commissioner.**

The Attack on the Alexander Bill

How the Proposed Legislation to Wipe Out Amateur Wireless Was Fought Before the Congressional Committee and the Demand for Prior Rights Recognized

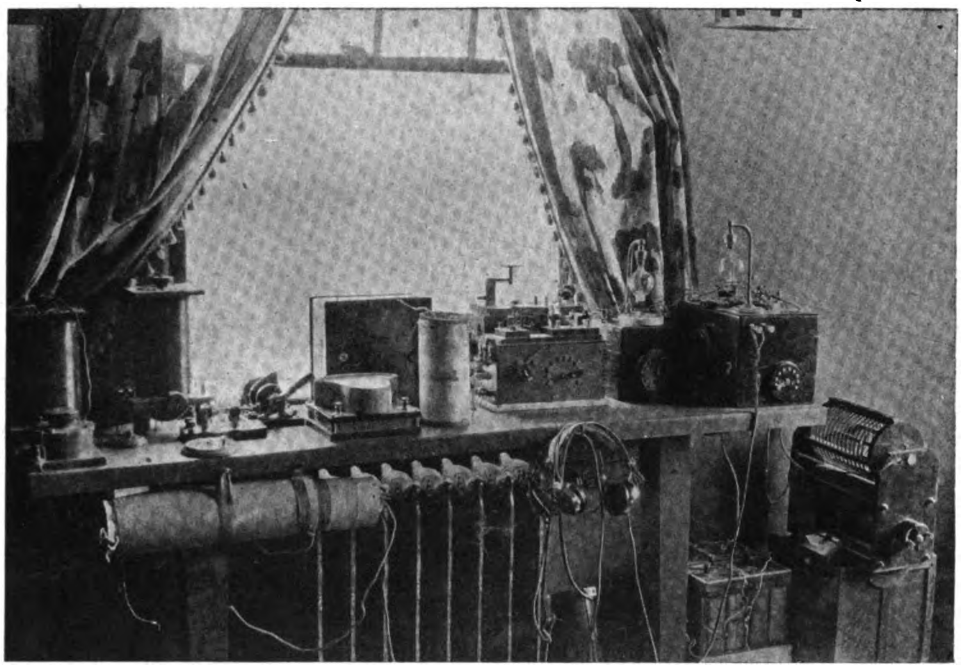
Reported by J. Andrew White

TO relieve the tension and satisfy the natural yearning for details aroused by the Washington dispatch, headed "Victory! Get Ready for Re-Opening of Stations," which appeared in the January issue, the account which follows has been prepared so all members may know what transpired in Washington in the matter of defeating the project for government ownership of wireless.

But—first of all—the amateurs of the United States are open to congratulation for the sane way in which their protests against the Alexander Bill were presented. N. W. A. Headquarters worked overtime replying to letters from members, prior to the opening of the Congressional Committee hearings; all inquirers were told that the matter was in the hands of a Special Committee of the Association and vigorous steps would be taken to kill the proposed legislation. And from what the N. W. A. representatives learned in Washington, the course prescribed was pursued to the letter. This time the "my-son-Johnny-is-being-deprived" type of letter did not appear; the written protests which the Congressmen received were dignified and awakened admiration for the high type of experimenter the field represents. The lesson from previous mistakes was well learned; when the amateur's case was presented this time it had lost the aspect of the youth in short trousers playing with a toy. Congress, from now on, will take amateur wireless seriously.

But, to tell the story: When the association's special Committee arrived in Washington the foundation had been well laid. All amateur interest had worked together in full harmony and so diligently that every member of the Congressional Committee had before him many well-written and pithy protests from all over the nation. Copies of the "Protests with a Point" articles, by the Acting President, the Technical Committee and Vice-Presidents Kennelly and Goldsmith—which were printed in full in the January issue—were placed in all the Congressmen's hands, along with the co-operative pleas of Mr. Maxim, Mr. Pacent, Mr. Rawson, Mr. Grebe and Mr. Grinan. From the beginning, the outlook was very favorable.

On the day before the hearings opened the Navy evidently considered the bill would fail because of the formidable amateur opposition. The officers of the American Radio Relay League were invited to meet in conference with the Naval Radio Officials to effect a compromise in the form of an amendment. The substance of this amendment—which appears a little further on in this article—was agreed upon, it being understood that a neutral position be then taken on the government ownership proposition. The amendment was introduced by the Navy on the very first day of the hearing. That evening an assemblage of leading and representative amateurs met at a dinner in the New Ebbitt Hotel. A difference of opinion developed in the matter of giving the Navy a monopoly, and in accepting the amendment. Twenty or more men, all representative amateurs, discussed these questions to a conclusion which showed the majority opposed, as individuals, to government control, and a desire to continue under the old law.



A wireless club's former receiving apparatus with a daylight range of 1400 miles; night range, 2,800 miles

Naval officials were told about this meeting on the following morning, the second day of the hearing, and advised of the belief that the bill and amendment would fail. **It was then admitted that the N. W. A. officials had been purposely left out of the conference because the attitude of the Association was known; that its officers would not accept any amendment on behalf of the amateurs and that it would actively oppose the proposal for a Naval monopoly, continuing its fight for the resumption of amateur wireless in peace times under the old law.**

That practically all the amateurs who later appeared before the Congressional Committee also took this at-

titude, without prior understanding, was gratifying to the officers of the Association, for it confirmed the belief upon which their stand was taken—the old law being satisfactory, no change was wanted, and no amendment of the Alexander Bill would be accepted as a compromise.

With complete victory now in sight, there is cause for mutual congratulation. Just how the discussion of amateur affairs was carried on in the hearings thus takes on renewed interest. The summary follows:

Secretary of the Navy Daniels appeared in behalf of the bill, which the Chairman stated was presented by the Navy Department in a large measure, in his belief. Mr. Daniels characterized the bill as one that would give the Navy Department the exclusive ownership of all wireless communication for commercial purposes.

One of the reasons for the proposal was that "the question of interference does not come in at all in the matter of cables and telegraphs, but only in wireless."

"We strongly believe," said the Secretary, "that having demonstrated in the war the excellent service and the necessity of unified ownership, we should not lose the advantage of it in peace." Because the naval organization fulfilled its purpose and won the commendation of not only our country, but of all countries during the war, Mr. Daniels reasoned that the service "is so well prepared to undertake this work and to carry it on that we would lose very much by dissipating it and opening the use of radio communication again to rival companies." The exact reason for the necessity of unified control under the Navy Department appears from Mr. Daniels' testimony to be great increases, present and prospective, in the number of vessels on our coasts and the consequent increase in radio communication on many different wave lengths.

Congressman Green of Massachusetts early in the hearing interrupted the Secretary of the Navy, with the opinion that his statement disclosed "government monopoly, contrary to any control that we hoped for years to establish under the Sherman anti-trust law. This becomes an immense trust, and it also becomes, according to my view of it, the establishment of the Department of the Navy in commercial business." He emphasized his indignation by continuing, "there are a number of gentlemen here who have had some experience in radio communication. I never heard before that it was necessary for one person to own all the air in order to breathe; and I believe that radio business has been and can be carried on without government monopoly. We all admit that during the war it was a very proper thing to have absolute control, but now in times of piping peace, it seems to me that there is a great opportunity to obtain advancement in the radio service even outside of the Navy Department. I do not think that all the wisdom is contained there; it has not been heretofore, and I do not think that it is all contained there now." Mr. Green was unwilling to consider that the Navy personnel was entitled to full credit for what had been accomplished. He stated that in time of war it was right that the Navy Department should have everything it needed, and that they have had it, and also all the advantage of the number of men who enlisted in the Navy for the purpose of extending the radio service. "I know of men in my own city," he remarked, "who were pronounced amateurs; yet they have some brains, and they have improved their brains and have improved their apparatus."

In the discussion of the imperialistic attitude of the Navy reflected in the bill, Congressman Saunders of Virginia, noted that it appeared that the average citizen would be inhibited from establishing a plant of his own. The Secretary of the Navy replied that the bill carried with it the authority to issue special licenses, which might be given wherever the public required it.

Mr. Saunders said he had not found such a provision in the bill, and Secretary Daniels read Section 5, as follows:—

That the Secretary of the Navy may issue special licenses, subject to such conditions and restrictions and for such periods as he deems proper, for the establishment and operation of stations for special emergency use—

"Yes, for 'special emergency'," Mr. Saunders interrupted. "Now that does not contemplate a general commercial condition, of course. It says, 'in cases where no other rapid means of communication is available'; that makes it more unlikely, therefore, that the man will be able to get any special permit."

The Secretary replied that licenses could be given if they did not interfere with the naval stations, which caused Mr. Saunders to observe, that this action could hardly be called "special emergency use in cases where no other rapid means of communication are available."

During the discussion which followed, the Secretary of the Navy struck out the objectionable features of that paragraph of the bill.

Congressman Saunders asked for a definition of interference from a naval point of view, and received the reply that by this was meant interference with the operation of the general system. The Congressman then observed that this appeared to be a matter of regulation as to the wave lengths to be used; to which Secretary Daniels replied, "we ought to have it absolutely—except in special cases—governmental owned and governmental operated."

Mr. Saunders criticized this viewpoint, saying that if that policy was to be pursued it would be difficult for private enterprise to show such a case of emergency, in fact, under the bill and policy the Navy had in mind, there would be no such private enterprise. This drew the admission from Secretary Daniels, "Well, in the main, there would not be."

Commander Hooper of the Navy replied to the question of Congressman Beshlin, of Pennsylvania, as to whether indiscriminate use of the wireless by people throughout the country interfered with its use by the government, to the effect: Amateur stations could be regulated so that they would not interfere, and still satisfy the amateurs.

Before the close of the first morning's session, the Navy apparently realized the futility of attempting to legislate the amateur out of existence, for at the conclusion of his testimony Secretary Daniels announced that, following the noon recess, an amendment to the bill would be presented by Captain Todd, Director of Naval Communications.

This amendment proved to be one concerning the amateurs. Captain Todd said: "The part of the bill providing for experiment stations I had hoped would cover the question of amateurs. Apparently, from what I have heard, the amateur wishes to be mentioned as such. I had an idea that it would dignify the amateur to have his station considered under the head of experiment stations." The amendment was presented with the comment from Captain Todd that he had every reason to believe that the amateur interests would be thoroughly satisfied. In substance the amendment was as follows:

The insertion of: "The term, 'amateur station,' means a station used for private practice or experiment in radio communication and not operated for profit in either receiving or sending radio signals."

The addition of the term "amateur stations" after the provision for "training-school stations," thus including amateur stations specifically in the provisions of the law.

Reframing the paragraph relating to licenses for amateur stations, licensed as private stations under the Act of Aug. 13, 1912, "Provided, that when such amateur stations are licensed for receiving purposes only, no operator's license shall be required for the operator in charge of operating such

station; but when such amateur station is licensed for transmitting also, the license shall require that the operator of such station shall hold a license showing his ability to send and receive at least 75 letters per minute in the Continental Morse code: And further provided, That the license for such transmitting station may limit the power input to one-half kilowatt in case of amateur stations within one hundred miles of the Atlantic or Pacific Ocean, the Gulf of Mexico, or the Great Lakes, and to one-quarter kilowatt within five miles of a Government receiving station. Amateur stations so licensed shall not use any wave length exceeding two hundred and fifty meters, nor less than one hundred and fifty meters, except by special authority in the license contained."

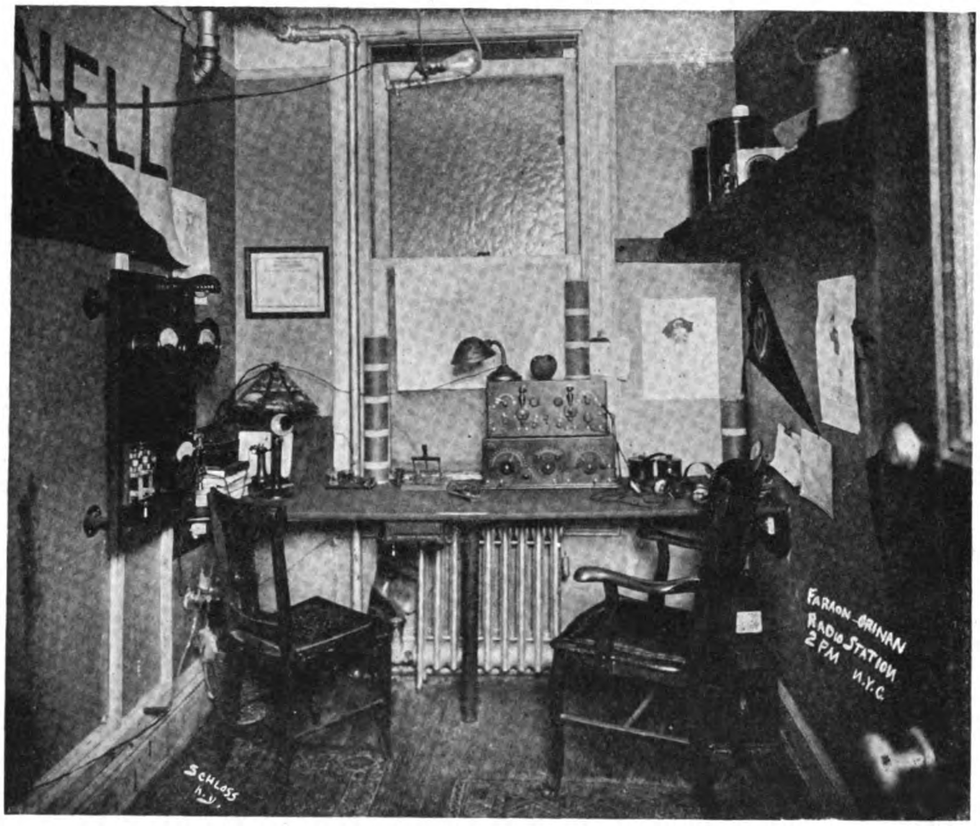
Captain Todd stated that he hoped that this amendment was satisfactory to the amateurs.

During the course of the testimony of the Director of Naval Communications, Congressman Edmonds of Pennsylvania, remarked to Captain Todd: "Of course, you realize that after this bill becomes effective there will be no radio schools, but simply experimental amateurs, and of course there will be no place for a man to get a position."

Congressman Green took exception to the lack of opportunity for the young men if radio was under government ownership. "Harking back to the early days before the days of telegraphy and other things," he said, "and before the days of travel by cars, the country started with very small beginnings and it has grown, and developed, and widened, and broadened, and beaten out all other nations, and now we come to tie everything up so tight that we have to be careful where we step. We have got to have our possibilities bound up by cords that we cannot break. We would be punished if we undertake to do anything. I am of the opinion that it is too much to ask the people of America to punish the people of America by restraining all their abilities and opportunities and all their hopes and expectations. You have to have some place of opportunity that young men can in the future get into, because they cannot get into the Navy because the Navy will not increase as it has during the war, and the Navy bottles up and keeps for itself the opportunities and keeps everybody out.

"I believe in the broadest chance to the American, and especially to the coming American," he continued, "and the coming American would be fully equal to the present, because the opportunities of education are far superior to what they were in my early days. I had no opportunity of education. I may have had the ability, but I did not have the opportunity to secure education, but had to go to work; and the youths that grow up today, even the young men born poor, have every opportunity, and I want them to have some inspiration. This bill ties up all the inspiration that every young man has."

The balance of Captain Todd's statement before the Committee was confined to the broad commercial questions in all wireless communication, other than those affecting the amateurs.



The Faraon-Grinan record breaking relay radio station, a typical amateur plant

He was followed by Lieut. J. C. Cooper, Jr., who announced that he was an ex-amateur who had been in the Naval service during the period of the emergency. Lieut. Cooper disclosed the interesting fact that several days prior to the opening of the Congressional hearing a meeting was called in Capt. Todd's office of all the ex-amateurs who happened to be on duty in the Naval Service in Washington. About thirty responded. It was as the collective judgment of these men that the amendment to the bill was offered.

Lieut. Cooper paid a high tribute to the amateur as a useful member of the community. "I personally, as a Naval officer," he said, "have had many operators under me. I have found that of the new men under me the easiest trained, the most adaptable to the new apparatus, and the most efficient men I had, were ex-amateur operators." He added that two of his best men had been put on the President's ship to receive the official messages from Washington, and that they were both ex-amateur operators.

The amendment, he noted, licensed receiving stations without requiring a license of the operator. In other words, the beginner need not be a radio operator to operate a receiving station. "We do not think,"

he observed, "on the other hand, that any amateur should have the right to touch a key and to cause possible blundering interference by his lack of ability as an operator unless he can receive and send what is usually called 15 words a minute, that is, 75 letters per minute, in the ordinary standard of 5 letters to a word. If he is required to have that degree of skill it will be an incentive to him when he is first learning the art."

He noted in connection with the amendment submitted by the Navy, a clause limiting the transformer input of amateur stations to one-half kilowatt if within 100 miles of the seacoast or to one-quarter kilowatt if within 5 miles of a Government receiving station. He gave his personal opinion that the limits were as reasonable as could be safe from a point of view of non-interference with official and commercial dispatches. He noted also that a license could be issued up to one kilowatt under these limitations, the amendment stating that the Government may in its discretion put these limits on. The amendment left it in the discretion of the licensing power to cut down to those limitations amateur stations near the centers of commerce, and still allow the amateur to work.

Congressman Saunders asked Lieut. Cooper for an opinion on the original bill, whether he considered that there was any provision whatever in it regarding the amateurs. Lieut. Cooper replied that he understood that it was the intention of the Navy to license amateur wireless operators.

Mr. Saunders disagreed, stating that he did not see where an individual who had been working an isolated amateur station for intellectual improvement would be covered by the term "experimental station." In fact, the Congressman insisted, before any man could start out as an amateur he must have had the opportunity to take some training at some school. The Congressman questioned Lieut. Cooper as to whether he could see any danger of interference with commercial or government message traffic, to which Lieut. Cooper replied, that he thought interfence was eliminated, "with the exception of the fact that adequate inspection of amateur stations must be had in the future if the amateur is to maintain the dignified position that he should in the radio world."

The ex-amateur sounded a note of warning as follows: "There is one coming factor in radio work which may adversely affect amateur operating which should be looked forward to at the present time. The fleet is using for intercommunicating purposes very short wave lengths, shorter than the 150 meters mentioned as the minimum length that an amateur should use. Aircraft are also using various wave lengths, some of which are almost down to 250 meters. There may be trouble in the future between aircraft operating overland and working with their receiving or transmitting stations, and amateur stations. That is a possibility of the future. Aircraft radio was not in existence to any extent when amateurs last operated. There may be interference between amateur operators and aircraft radio stations, but it is hoped that there will not be."

Mr. Saunders then brought out the point that government ownership had nothing to do with that problem, and that it could be met by appropriate regulation.

Commander S. C. Hooper, Executive Officer, Radio Division, Bureau of Steam Engineering, Navy Department, was called. He prefaced his general statement with the following observation:

"I do not think that it will be out of the way if I should pay tribute to the fine co-operation and the fine work of the radio manufacturers and inventors and amateurs in our country. When war came on us we were totally unprepared to handle the entire situation. The amateurs saved the day when we had to man the entire merchant marine by naval operators in order to incorporate the merchant marine into the naval system.

"The manufacturers came down to Washington and placed themselves at our disposal, and in every way possible did their utmost to further the plans and slightest desires of the department. The inventors were keen and active in every effort in their research work to produce what might be used against our common enemy. I take particular pains to mention the assistance given by Mr. Nally, vice president and general manager of the Marconi Company, whose company more than anyone else suffered through what war brought upon them; and also of the Federal Telegraph Company, which stood next in being harmed, due to the Government closing the stations.

"These officers have performed a service as great as any military officer in the radio work for the Government in time of war, and this service should be recognized in some way. They know in their conscience that they have done a great good to the country, the same as the soldiers and sailors have done, and it ought to go down in the records of history that they have done their duty."

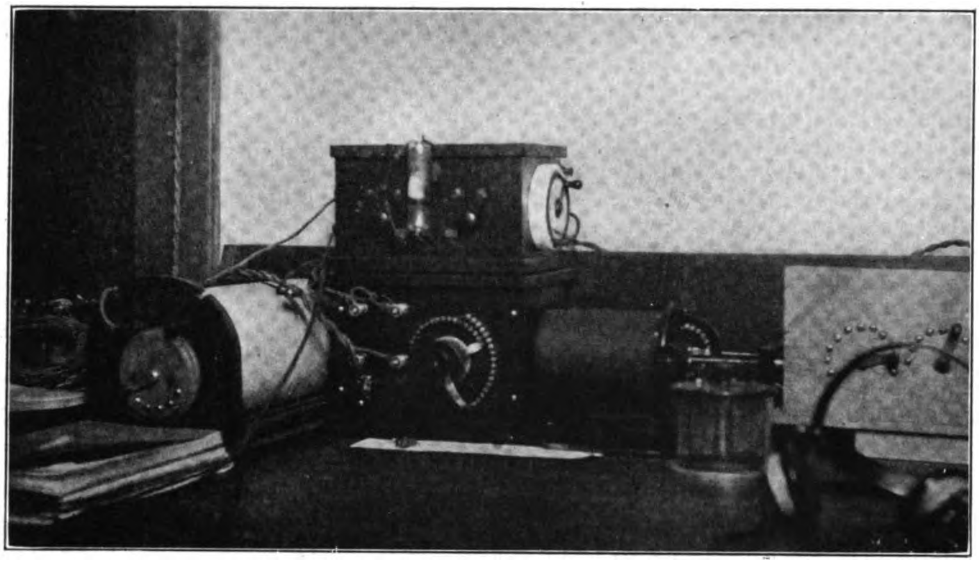
His testimony was mainly on the technical point of view in the subject of government ownership, dealing principally with the cause of interferences. In connection with the amateur problem he stated: "I agree it is very interesting to the amateur, and very educational, and it is a great advantage to the radio art to permit the amateurs to develop themselves, and it is of great value to the Government to have all these operators self-trained in case war comes upon us.

"The amateurs, of course, cannot afford to expend large sums of money on radio stations and build aerials for long wave lengths, and naturally they prefer to have the short wave lengths and small aerials, which fit admirably into our organization and are in accordance with the present law."

Edward J. Nally, vice president and general manager of the Marconi Wireless Telegraph Company of America, who appeared in opposition to the bill, observed in the course of his testimony that if the amendment represented the joint view of the Navy officials and that of the amateurs, the Marconi Company "was glad to add its voice in approval, and to express the opinion that the proposed regulation covering both amateur radio operators and amateur radio stations is both sound and equitable."

Hiram Percy Maxim, President of the American Radio Relay League, presented a plea for amateur wireless toward the end of the hearing, stating that the proposed regulation disclosed a short-sighted policy on the side of the Government, unquestionably imperialistic and thoroughly un-American. He noted that in 1912 those who had erected small private wireless stations were given legal standing in the law under the name "amateurs." In a review of amateur operation he noted especially that the amateurs themselves undertook to reduce unnecessary interference and to set higher standards of efficiency; in fact at the outbreak of the war a proposal had been made to the Department of Commerce for the service of deputy inspectors, organized to report amateur violations as to power, wave length, wave purity and decrement. These inspectors were to be selected from the amateur ranks and to serve at a dollar a year.

In estimating the extent of the experimental interest in radio, he expressed a belief that there must have been 175,000 amateur wireless stations in this country at the outbreak of the war. Of transmitting licenses issued prior to the day of closing, the Commissioner of Navigation stated the actual number to be 8,562.



O. R. Terry's pre-war wireless station at Stoughton, Wis., another amateur assembly

broadly speaking, it was satisfactory to the organization he represented. On the question of government ownership, he stated, "We have no comment to make upon the question of Navy control and ownership of communication."

Congressman Burroughs of New Hampshire, inquired, in connection with the proposed amendment, whether the amateurs would not object to the requirement of 75 letters per minute in the Continental code. Mr. Maxim spoke for the American Radio Relay League as an organization, stating that they would not object to it. He noted further that the league's membership was only 4,000 members, and there were other amateurs beside them. It developed on questions from Congressman Edmonds, that second grade commercial operators were required to send but 12 words, or 60 letters, per minute, whereupon Mr. Maxim said the amendment's provision was too high, and that the required speed should be no higher than that for a second grade commercial license.

Estimates of the investment represented in amateur wireless stations were placed at ten million dollars. Five amateurs were named who respectively had invested in amateur apparatus for their individual use $5,000, $15,000, $2,500, $5,000 and $2,000. It was also emphasized that the majority of the amateurs in the country were men between the ages of 20 and 30; not, as popularly supposed, boys in short trousers. Twenty-eight electrical supply houses furnishing apparatus to amateurs were listed as typifying the extent of the industry which the law would, at a stroke, wipe out. He estimated the commercial capital they had invested to be from two to three million dollars.

The developments which accompanied wireless experimentation were exemplified by the case of an amateur who was working on a means for the separation of oxygen and nitrogen from the atmosphere, and another case where promising experiments were being made in the joining of metals, both suggested as the result of working an amateur station.

As to the war utility of amateur training, Mr. Maxim quoted from a letter written by a former amateur, who with two friends, enlisted together. "I was the only one of the three that had amateur experience. I finished the training of the electrical class, Brooklyn Navy Yard, in three weeks and went to sea. My two pals took seven months and they did not begin to know what I did." Lieut. Tuska is also on record, stating that in aircraft radio a man without previous experience required fifteen to sixteen weeks to become an operator, whereas an amateur was made ready for service in as few as one hundred hours.

A list of 51 former amateurs serving in the military establishment was introduced, to illustrate their value in time of war. Mr. Maxim then noted that in spite of the utility of experimenters, the bill introduced made not a single mention of the amateur, entirely eliminating him. "It is not satisfactory to us," he said, "to gloss over this question by explaining that the amateur is tacitly included under 'experimental stations.' Such an explanation is to our minds indirect, doubtful, and not what we regard as straightforward and square treatment. Such an arrangement would leave us at the mercy of unfriendly interpretation of the law."

Mr. Maxim, in the early part of his statement, urged the adoption of the amendments which referred to the amateur, and which were presented by the Navy Department. Congressman Bankhead of Alabama, inquired if this amendment was entirely satisfactory to the amateur interests; to which Mr. Maxim replied,

Congressman Green later referred to the government ownership provisions of the bill, stating: "This proposition as it comes before us is to broaden the opportunity of the Navy to go into commercial business and I want to know whether you amateurs have given any consideration to the fact of the Navy entering that field." Mr. Maxim replied that there was no comment to be made upon that at all, whereupon Congressman Edmonds inquired: "You do not think it will prevent boys from studying wireless because there is no place for them to go, if they want to make a business of it in the future?" Mr. Maxim said he could see where that might be used as an argument.

Mr. Green than referred to the plans of the Department of Commerce to develop foreign trade. Ascertaining that Mr. Maxim had not given any thought to that part of it, he gave the opinion: "you are bound up with the Navy to put this proposition through."

The Congressman stated that he was a great believer in the expansion of trade, and wanted to get something to show that this bill would promote that expansion. His understanding was that it was a contraction, that it meant contraction of trade, and he wanted Mr. Maxim's ideas on that point. The witness asserted that he did not feel himself competent to answer that question.

The question of the amendment's reduction of amateur power to ½ kilowatt was introduced by Mr. Edmonds. Mr. Maxim replied that he thought it a reasonable request to limit the amateurs to ½ kilowatt, and considered it a very healthy condition. As to the ¼ kilowatt within 5 miles of a government receiving station, he stated if evasion or advantage was taken of that provision, then he was opposed to it. This followed the supposition by Congressman Edmonds that a naval officer could install a receiving station in his home, and because the government paid the rent of the house it would technically become a government receiving station.

Mr. Maxim, in later discussion, withdrew his approval of the 75-letter-per-minute provision of the amendment, as it was developed that the intention had been to make this the same as the requirement of a second grade commercial operator, 60 letters per minute,

On question, Congressman Hadley of Washington, developed that to Mr. Maxim, the situation was satisfactory if the bill was not passed, the amateur stating that it had been proven satisfactory by the last five years of experience. Mr. Hadley then had confirmation of his opinion that the proposed amendment had merely been offered for self-protection, to reconcile the difference between the amateurs and the Navy as proponents of the bill.

The administration of amateur wireless affairs in the hands of the Department of Commerce in the past had been cordial and satisfactory, Mr. Maxim agreed, and gave his judgment that they would like very much to go back to their "old love."

Francis F. Hamilton, representing the Hoosier Radio Club of Indianapolis, appeared before the Committee and stated that he had recently been an instructor in the Signal Corps. He reiterated the value of preliminary amateur experimentation in preparing men for military service. The first group of students which he handled had been nearly all amateur operators and became very proficient in military signaling when they were through that course. The next group knew nothing of amateur wireless, and after 13 weeks of training, they knew less than when they started.

He gave his opinion that one of the greatest benefits of amateur work was the fostering of ambition; "many amateurs dream of the day when they may be on a large ship at sea operating a wireless station," he said. "With that in view, what is the chance of amateurs operating ship stations after they have fulfilled the requirements, if this bill passes? Why, an amateur would have to join the Navy first, and put himself under military authority in order to develop his commercial profession and ambition!" It was his belief that the amateurs would not look upon this course as desirable.

In further opposition to government ownership, he stated that one who had a fundamental patent on radio apparatus would have no right to use it without giving it to the only bidder, who would be the Secretary of the Navy. Congressman Hadley interposed, "You want a broader market for the inventor?" Mr. Hamilton replied that he wanted a broader market than there would be if the bill should go through. Congressman Hadley then developed the opinion from Mr. Hamilton that private monopoly would be more liberal to inventors than a government monopoly, the thought being that the government was interested in public welfare, whereas private interest would be interested in getting the profit out of the patent. Mr. Hamilton instanced, as an illustration, the purchase by the Marconi Company of the patent of Professor Pupin. He expressed high hopes of amateurs inventing apparatus which would force the commercial companies to buy the improvements "if the wireless business is not bottled and corked up by the Navy Department as this bill proposes."

The Hoosier Club representative stated his belief that should the Congressmen on the Committee themselves become amateur operators, they would much rather be under the Department of Commerce than under the Navy, adding in reference to the amendment, "I want to go on record as stating that I do not see any valid reason why the present law should be changed."

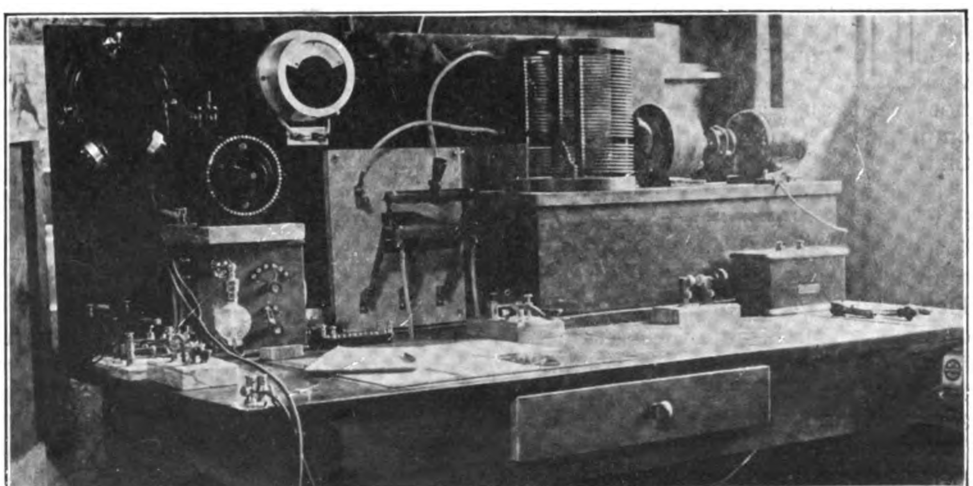
Congressman Hadley said that it was represented to the Committee that the amendment represented an agreement which was satisfactory to both sides. "Mr. Maxim represents a certain number of amateurs," Mr. Hamilton replied. But "each amateur is a little company of his own and each man will have his own ideas. I think that Mr. Maxim said himself that if it were possible he would like to see the law left as it is, but if it were not possible to do that, he would agree to this amendment."

Mr. Hamilton also discussed some of the phraseology of the proposed amendment, disclosing that it did not permit experimentation for profit. On the questioning of licensing receiving stations, he had no objection, but he thought that 50 letters a minute, or 10 words, was "plenty strong enough a requirement." "We do not want these people to be experts," he said; "the old law requires 25 letters per minute but we are willing to make it 50." He further noted that the amendment limited amateurs to ¼ kilowatt within 5 miles of any governmental receiving station. This provision he believed would apply to a station which had been established in the Post Office building in Indianapolis, which he instanced as the likely forerunner of many more receiving stations to be placed on Post Office buildings. He stated that the amateurs he represented would not agree to accept an amendment of this kind. The possibility of the Post Office Department extending its service and putting receiving stations on Post Office buildings in cities of any size should be anticipated.

As particularly limiting the amateurs to ¼ kilowatt, a communication from the Baltimore Radio Club was offered, stating that the members would agree to 12 words per minute, but were opposed to limiting the amateurs to ¼ kilowatt within 5 miles of a government receiving station.

Congressman Humphreys asked Mr. Hamilton's opinion on the creation of a commission to determine wave length and power to be used by amateurs. Mr. Hamilton reiterated that the present law was satisfactory and sufficient. Congressman Green observed: "As I understand it, the amateur is satisfied with the present law, which they had before the war. They have been efficient in the war, and now they want to go back to their former position, and here comes a new law that ties them up so they cannot get back to where they were. I cannot see any reason, after they have rendered good service to the government, why they should not have a chance to return to their former status."

"That is absolutely the condition," confirmed Mr.

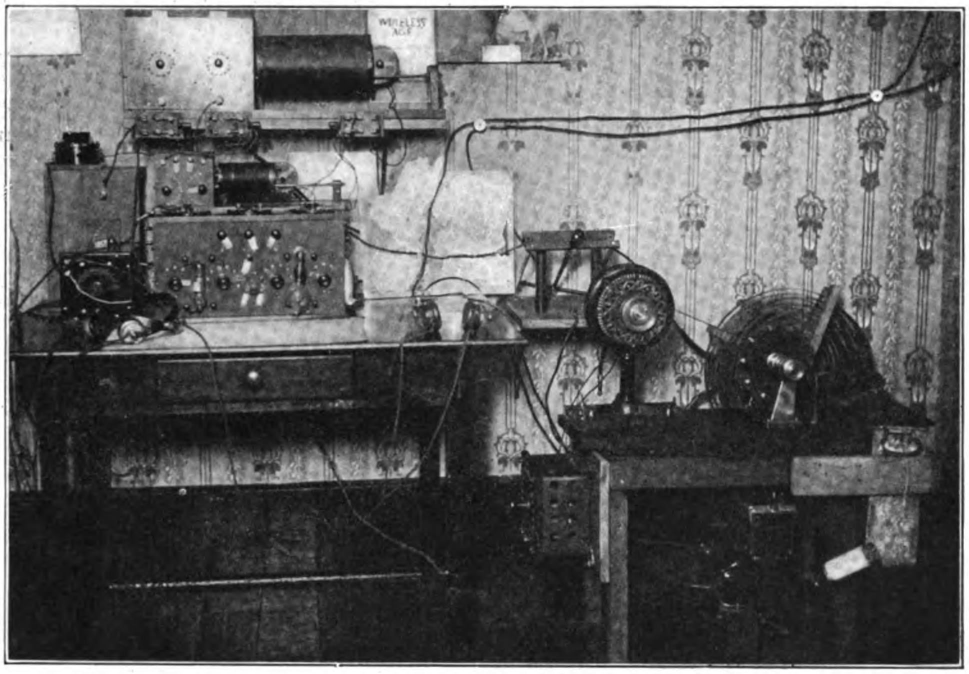


Amateur wireless station operated before the war by A. M. Lindsay, Jr., of Rochester, N. Y.

Hamilton. "None of these amateurs would be here today if that bill had not been written so that it would cut them clear out. The Department of Commerce has treated us fine and we have always gotten along well with them. There is no reason why we should change, that I can see. There is no objection to the existing law."

The next amateur opponent to appear was Edward C. Andrews, president of the Wireless Association of Pennsylvania, who stated they were "unalterably opposed to the change in the present law. We see absolutely no reason for it," he exclaimed, "and lots of reasons against it." The paramount reason was that the Navy sponsored it.

The bill would remove the incentive for experiment, he believed. Experimenters "would have to enlist in the Navy in order to carry on the studies they have undertaken," and "if we have no incentive and no place for any one to go and sell apparatus, naturally that puts an end to experimentation," were two of his pertinent utterances in opposing naval monopoly.



Wireless station owned and operated before the war by Mr. and Mrs. C. Candler of St. Marys, Ohio

Dr. Gordon M. Christine followed Mr. Andrews. He explained that medicine was his profession, and his age was 61, but he was an amateur in wireless telegraphy and had become intensely interested in the art. The work should go on as it was before the war, in his opinion, and he could not understand why power should be reduced to ¼ kilowatt in the amendment to the bill. "We do not like this amendment; we do not want any amendment at all!" he added with emphasis. "Give us this old law. Do not disturb that."

Congressman Beshlin inquired for the Doctor's opinion as to the difference in control by the Department of Commerce and the Navy Department. "My own opinion," he replied, "is that the treatment which the Department of Commerce has given us has been that of man to man; and the treatment which the Navy would give us would be the treatment of a high official to a civilian." Many amateurs seemed to be more afraid of naval authorities than civil branches of the government, stated Congressman Humphreys, referring to the proposed control. "I believe that the Navy has it in for the amateur and wants him out," was the answer returned by Dr. Christine. It would not have presented the original bill if it did not, he thought. "But they became somewhat alarmed at the tremendous uprising of the amateur throughout this country at the prospect of being deprived of their outfits." Questioned by Congressman Hardy, the physician said that the language of the original bill led him to believe that the Navy had something against the amateur.

Congressman Edmonds thought the objection reasonable. "The Department of Commerce is a business department," he said; "and it is used to handling business, and in its report it speaks very highly of the amateur operators. Undoubtedly they have got along very well together, and I do not blame the amateur operators for coming here and objecting to a change in the departments. If I were they, I would do the same thing myself, because they know what they can get from the Department of Commerce and do not know what they can get from the Navy Department."

Joseph Heinrich, a thirteen year old amateur of Washington, received a cordial reception for his courage in appearing before the Committee. The boy put in a strong plea for the rights of the amateur and received the assurance that the Congressmen were not unfriendly.

Charles H. Stewart, of St. Davids, Pa., who has previously appeared for the amateur in opposition to prohibitive legislation, made a brief address. He seconded the expressions on the matter of leaving wireless under the Department of Commerce and noted that operating speeds for sending station licenses could be changed by regulation, no further law being required to do this.

Harry W. Densham, secretary of the South Jersey Radio Association, confirmed what his predecessors had said in opposition to the bill.

Frank B. Chambers, of Philadelphia, added to the testimony for the amateurs, illuminating various points discussed by amusing and graphic word pictures. He also objected strongly to Navy control, and echoed the consensus of opinion that the present law should remain in force without alteration.

(Continued on Page 44.)

Experimenters' World

Pertinent Suggestions for the Experimenter's Workshop

By E. T. Jones

Experimental Carbon Amplifier

The description of an amplifier for radio signals I constructed as follows:

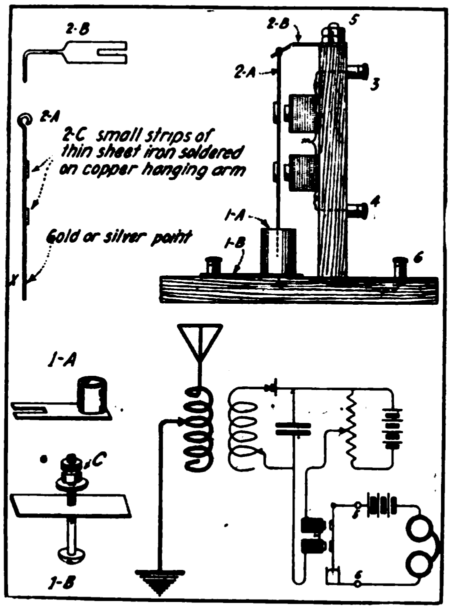


Figure 1—Detailed plan of construction and circuit of the carbon amplifier

Two magnets from a 1,000 ohm receiver are mounted as shown in figure 1 and suitable connections thereto provided by the binding posts 3 and 4. On the base is mounted the cup which holds the carbon granules. It is made adjustable by providing a slotted strip of brass as shown at 1-a which slides over and makes contact with the brass strip 1-b and is held or clamped when the desired adjustment is obtained by the locknut c. The dipping arm 2-a is made of copper wire about No. 24 preferably gold pointed (at x the part which dips into the granules can be gold plated or a small piece of gold wire soldered thereon). The top of this No. 24 wire is bent so as to form a circle and fits on the arm support 2-b which allows it to move freely. The end of this dipping arm is allowed to rest in the cup, 1-a of carbon granules. The arm support 2-b is fastened to the same support which holds the magnets and a binding post is supplied to furnish a connection from the dipping arm through the cup. The detail 2-c is made of two strips of iron which act as armatures for the telephone magnets. They are soldered on the copper hanging arm which dips into the carbon granules.

This amplifier when properly constructed works exceedingly well, and owing to the fact that it is simple in construction there is no reason why pains should not be taken to make as good a job as is possible with the material at hand.

Under actual working conditions the amplifier functioned with a signal whose audibility was a little more than 100. The dipping needle if not provided with a silver or gold point will not work as well, and will have to be constantly cleaned. Better results were obtained by inserting another receiver of 1,000 ohms in series with the two mounted magnets making in all 2,000 ohms. The carbon granules should be of the finest grade and the inside of the cup or retainer should be kept clean. From time to time it is well to remove the granules and clean them. If it is possible to get several of these amplifiers to function efficiently, then the cascade connection can be resorted to for further amplification. As an experimental instrument this is a good one but there is plenty of room for improvements in connection therewith.

A Magnetic Rectifier for Alternating Currents

A magnetic apparatus for A. C. rectification is shown in figure 2. A permanent bar magnet (marked N and S) is pivoted at the center by drilling a hole through the bar and passing an 8/32 screw through same. Both ends rest in the holes made in support A. The magnet B is taken from any old

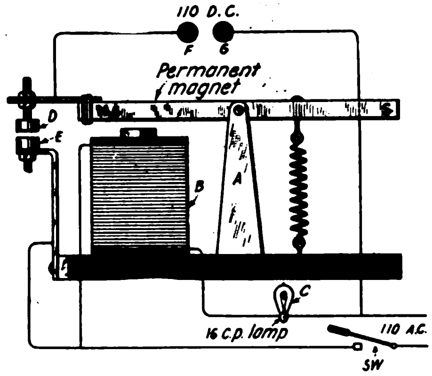


Figure 2—Construction of magnetic rectifier for alternating currents

sounder or constructed along that size throughout. This is in turn put in series with the 16 C. P. carbon lamp C so as to prevent the windings from burning out and at the same time perform its duty. Two contacts are furnished which are insulated from other parts of the mechanism D and E.

The apparatus works on the fundamental law of magnetism; LIKE POLES REPEL and UNLIKE POLES ATTRACT. The alternat-

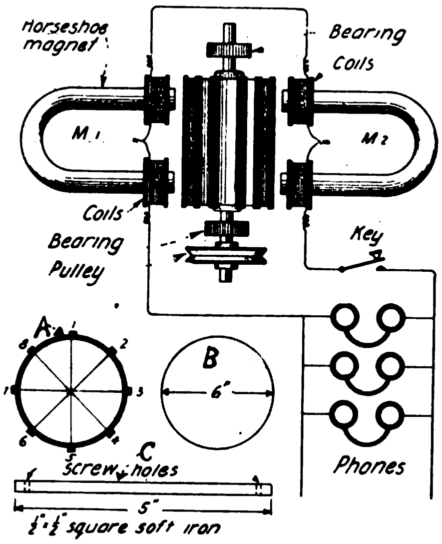


Figure 3—Diagram of construction and circuit of the high frequency generator

ing current flowing through the magnet B changes the poles of its core according to the frequency of the current entering its windings. But at the same time the steel bar magnet retains its poles. The result is that when the current entering the magnet produces a north pole at the top end of the electro-magnet there is no attraction, since like poles repel, but on the other half of the cycle the poles of the electro-magnet are reversed and the top end is made a south pole. Then the law holds good that unlike poles attract thereby drawing the two contacts D and E together causing current to flow through the contacts F and G as direct current. This performance continues so long as the current is turned on at H.

An Economical and Efficient High Frequency Generator for Code Practice

Having had the pleasure all these years of experimenting with several types of buzzers I have found that the contact points always burn out after any considerable use, and numerous other troubles present themselves. I have constructed a form of high frequency generator which gives a clear note of constant amplitude in the tele-

phones and has many advantages which are only to be appreciated under operation. Means should be provided to regulate the strength of signals in the head telephones according to the number of head sets on the line.

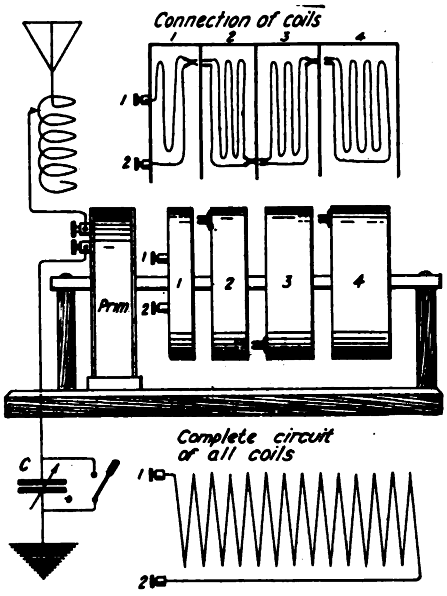


Figure 4—Design and connections of the complete receiving transformer

It is also possible to take off parallel wires and run them to the various tables in series with the ordinary telegraph key for each table.

The apparatus completed is shown in figure 3 where a drum as in detail B is constructed of two round ends of wood 6″ in diameter and about 1″ thick upon which are mounted bars of soft iron ½″ by ½″ thick and 5″ long. A suitable shaft is run through the centre and two bearing supports are provided together with means for oiling. As is seen in detail A, eight iron bars spaced evenly apart are screwed to the wood ends. This drum is rotated between the two horseshoe magnets M-1 and M-2 upon which have been wound coils consisting each of 200 turns of No. 28 D.C.C. wire. Magnet M-1 is adjusted to have its magnetic circuit completed by the movable iron bar just after magnet M-2

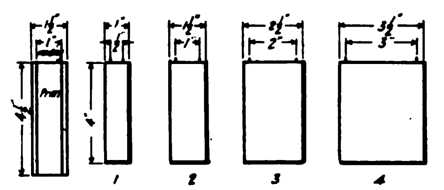


Figure 5—Showing dimensions of primary and secondary coils and their windings

has had its magnetic circuit broken. This gives double the frequency to be obtained with one horseshoe magnet. A suitable pulley about two inches in diameter is mounted on the drum and and a five inch pulley on the motor turning 1500 R.P.M.

In practice considerable frictional losses were experienced owing to the fact that I did not have good bearings and means for oiling them continuously. Therefore, it is wise to benefit from my experience and secure good bearings and an adequate oiling system. As a whole the apparatus is very interesting under operation and provides a means for demonstrating the principles of alternating currents to students during lecture periods.

An Up-to-Date Receiving Transformer

Radio fans are on pinions waiting for the word GO from our Government. Many will construct as the first part of their equipment a receiving transformer. I believe that the design shown in figures 4, 5 and 6 which I have tried out will be a valuable adjunct to their station. This tuner is fitted with a primary coil consisting of thirty turns of wire, this number being sufficient for general practice. Further variation of wave length in the antenna circuit is secured by the loading coil L, external to the transformer. Response from short waves

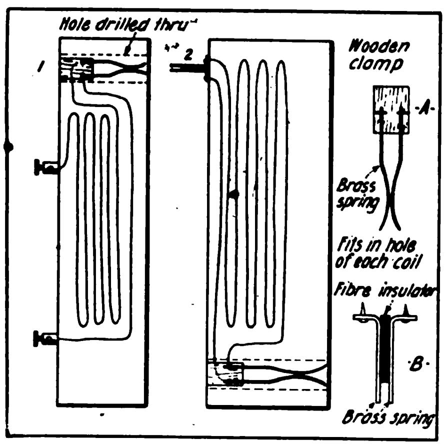


Figure 6—Detailed construction of the plug switch

can be secured by means of the series variable condenser C.

It is to be especially observed that the secondary winding is broken into four units and means are provided whereby they can be connected together by means of a special plug. The primary winding is made on a form, 4½″ in diameter, 1½″ in length, wound for 1″ with 30 turns of No. 22 DCC wire. Approximately 35 feet are required.

The first coil in the secondary is 4″ in diameter, 1″ in length, wound for ½″ with 22 turns of No. 28 DCC wire. Twenty-four feet are required. Secondary unit No. 2 is 4″ in diameter, 1½″ in length, wound for 1″ with 45 turns of No. 28 DCC wire. Forty-seven feet will be required. Secondary unit No. 3 is 4″ in diameter, 2½″ in length, wound for 2″ with 90 turns of No. 28 DCC wire. Ninety-four feet are required. Secondary unit No. 4 is 4″ in diameter, 3½″ in length wound for 3″ with 135 turns of No. 28 DCC wire. One hundred forty-one feet will be required. The total secondary therefore will consist of 292 turns or 306 feet of No. 28 DCC wire. The measurement of all parts are shown fully in figure 5 and the details of the plug switch at A and B in figure 6.

If desired additional secondary units can be provided. Each successive coil should be larger than the preceding one as in the design already shown.

A suitable shunt condenser must be connected across the secondary. In this way, a closeness of adjustment not possible with the secondary inductance alone, can be obtained. The principal advantage of my design is that the unused turns for a small range of wave lengths are disconnected from the used turns which, as is well known, increases the efficiency to a remarkable degree.

A Modulator of Continuous Oscillations

THE successful reception of signals from stations emitting undamped waves requires some means for reducing the radio frequency currents to audio frequency currents of less than 20,000 cycles per second. This can be accomplished in a number of ways, such as by the use of a tikker that breaks the circuit at a speed great enough to give an easily read note in the receivers, by utilizing an interfering current to produce "beats" or current peaks as in the heterodyne system, or by tuning and detuning the circuit at high speed to give an audible note.

The latter method has received little attention from experimenters and should be a fertile field for investigation. The revolving condenser method has been described previously but the instrument described in this paper uses an inductance to tune and detune the circuits. The device is nothing more than a small variometer so constructed that the inner coil can be revolved at a high speed.

In figure 1, is given a broken view of the device to show its assembly. The constructional details and dimensions are given in figure 2. A square, wooden frame is used to support the stationary coils. This should be assembled with small brass screws, one end being left off till the rotor is in place. Bearings for the rotor are made from brass and mounted in the ends as shown.

The rotor is made from a two inch

length of shade roller or other wooden stick one inch in diameter. A slot one-quarter inch square is cut in opposite sides to take the winding. Holes are drilled in the ends to take one-quarter inch brass rods of the lengths given

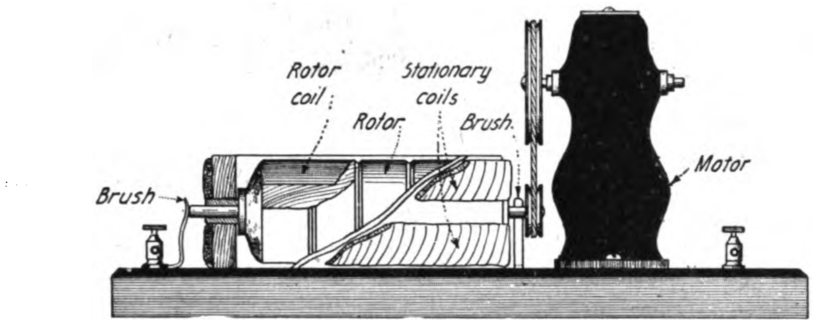


Figure 1—Assembled view of device for modulating continuous oscillations

to form a shaft. Grooves are cut around the rotor for the fine silk or linen binders that hold the winding in place.

The rotor is wound with No. 28 B & S, S.C.C. copper wire. One end of the wire is soldered to one shaft and the wire wound around in the slots similar to a telephone magneto. A little tape should be placed around the shaft where the wire touches. The winding is done in smooth layers, a slip of thin pasteboard being put between layers to keep them smooth and reduce the capacity effect of the winding. When the slots are full the other end of the wire is soldered to the other shaft. A piece of cardboard is put in

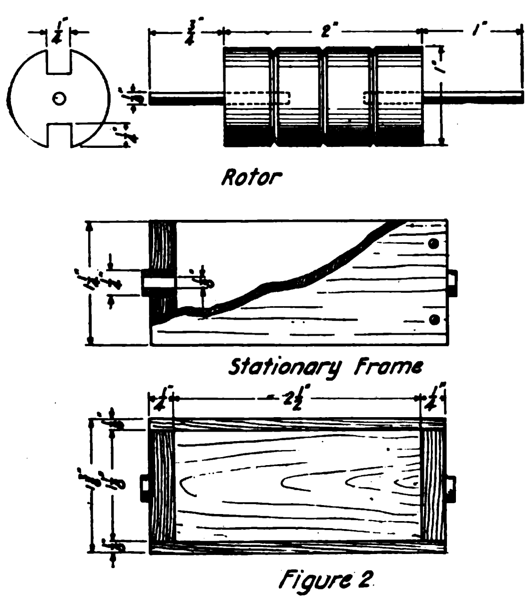


Figure 2—Showing constructional details and dimensions

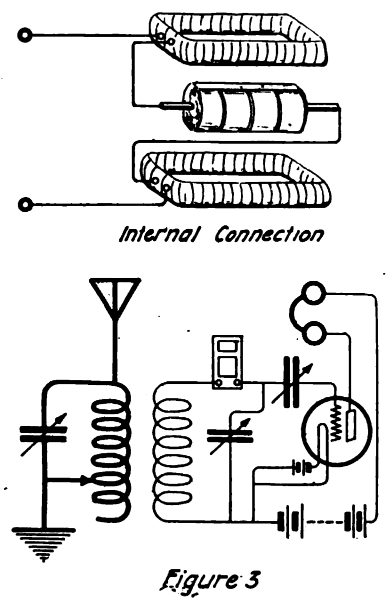


Figure 3—Showing method of wiring the device in the receiving circuit

each slot over the winding and then bound in place with fine silk thread.

The stationary coils may be wound right on the square frame after the rotor has been put in place but it is preferable to make them so they can be easily removed. Each coil of the stationary winding should contain one-half the number of turns on the rotor, they being made of the same size wire. The form used for winding them should be a trifle larger than the square frame, a winding space three-eighths of an inch wide being used. Thin pasteboard should be placed between layers to stiffen the coils and also reduce capacity losses. After being removed from the form the coils are served with a layer of tape to keep them in shape.

The motor used for driving the rotor should be of the series type to give a high speed which can be controlled by a small rheostat. A heavy rubber band forms a very satisfactory belt for the device.

The usual method of wiring this instrument in the receiving circuit is shown in figure 3. By bringing out the leads from the rotor and stator to separate binding posts the experimental possibilities of the device are greatly increased.

Thos. W. Benson, *Pennsylvania*

Long Wave Variometer

The variometer possesses a number of features that make it suitable for close tuning but the conventional type with concentric coils limit the range of wave length over which it is possible to tune. This is due mainly to the fact that the winding space must be made very narrow if the coils are to fit closely. Increasing the space results in an instrument with the coils so widely separated that the range is limited and quite a lot of inductance remains in the circuit when tuned to the lowest point on the scale. Realizing the advantages of close tuning and lack of end-turns, the writer has designed an instrument with these advantages that will respond to the higher wave lengths.

This type of variometer can be built for any range of wave length with the simplest of tools. The instrument described will work up to 10,000 meters and is intended for use in oscillating or Armstrong circuits, as a plate circuit loading coil.

Instead of two concentric windings it employs four coils so mounted that by revolving two of them about an axis their magnetic lines can be made to assist or oppose those of the stationary coils and thus obtain a gradual variation of inductance without any dead wire in the circuit. The dimensions of the coils can be changed to suit conditions, the instrument described being merely an example of this type of instrument.

The four coils are all similar in construction, being wound on wooden cores three inches in diameter and two inches long. Heads four inches in diameter are cut from thin fibre and fitted to the ends with glue and brass pins.

The winding is put on in four layers. The first being wound on the core, then a strip of corrugated board being cut to fit snugly around the winding and put in place. Four layers will fill the coils.

The method of assembling the coils is shown in the illustration. The cabinet used with the above coils should measure 9 x 9 x 5¼ inches inside. Two of the coils A and A-1 are mounted on the back, one above the other with a space of ¼ inch between them to pass the brass rod E forming the axis for the movable coils. The windings of these coils are so connected that when viewed from one end the current will flow around them in opposite directions.

A sheet of thin fibre or stiff pasteboard with a ¼ inch hole in the center is fitted into the box in front of the coils to form a smooth surface over which the coils B and B-1 can turn. The moving coils are fastened to a strip of wood D, ¼ inch thick,

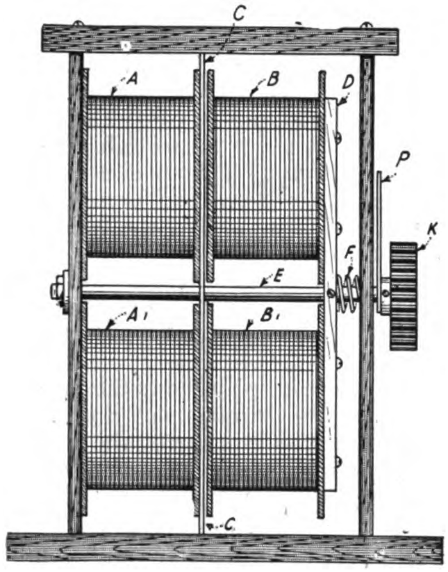


Figure 1—Showing method of assembling the coils of the long wave variometer

½ inch wide and 7¼ inches long. When mounted the coils have a space of ¼ inch between them at which point a hole is drilled in the wood strip to pass the brass rod. A small wood screw is put in one side of the strip opposite the hole to clamp the strip to the brass rod. The connections of the moving coils is similar to that of the fixed coils, so that the current will flow around them in opposite directions. Flexible leads are used to make connections to these coils.

The instrument can be completely assembled by passing the brass rod through the back of the cabinet and the fibre sheet, and slipping the strip over the rod so the coils rest against the separator, making sure to clamp coils B and B-1 by means of the small screw provided.

The four coils are then connected in series, with leads brought out to binding posts. The small spring F is slipped over the rod and the front of the cabinet put in place. A knob and pointer are attached to the projecting end of this rod to operate the instrument. A scale is mounted on the front of the cabinet. This is in the form of a semi-circle since one half-turn will vary the inductance from minimum to maximum. The pointer should be attached in such a position that when at the highest point of the scale the coils are in such a position that the current will flow around both top coils in one direction and around the lower ones in the opposite direction.

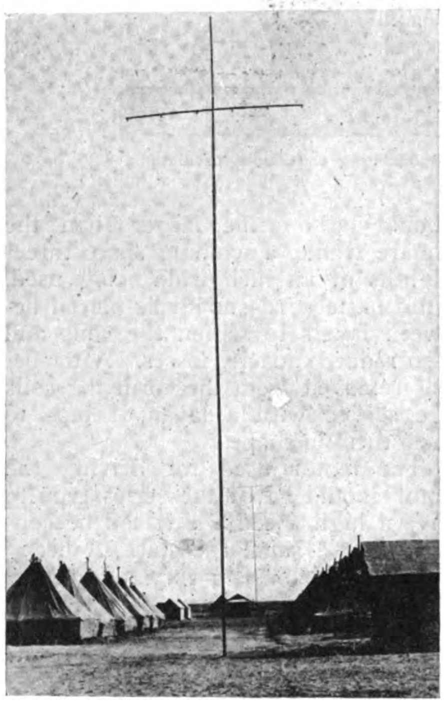
The instrument is now complete and ready for use. By bringing out separate leads from the coils numerous experiments are possible that will make the instrument a favorite of the experimenter.

THOS. W. BENSON—*Pennsylvania.*

U. S. Signal Corps Radio Station

THE camp station of the Radio Co., 1st Pennsylvania Signal Troops, while quartered at Camp Stewart, El Paso, Texas, is shown in the accompanying photographs. Particular attention is directed to our method of driving a pack set generator with an engine rather than by hand. This method gave very excellent results.

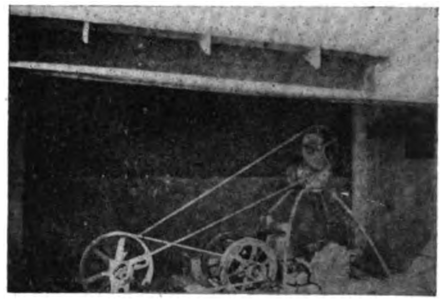
The masts are 60 feet in height and the span 350 feet in length. Using ¼ kw. pack set excellent signals were received at Colona, Dublan and El



The masts were 60 feet high and had a span of 350 feet in length

Valle in the daylight hours over a distance of 160 miles. Press and time signals were received from Radio, Va., every night and practically all commercial stations on the Atlantic and Pacific coasts were heard at one time or another.

K. B. HAINES, *Pennsylvania*



Novel method of driving a pack set generator with an engine instead of by hand power

My Views of the Amateur Situation

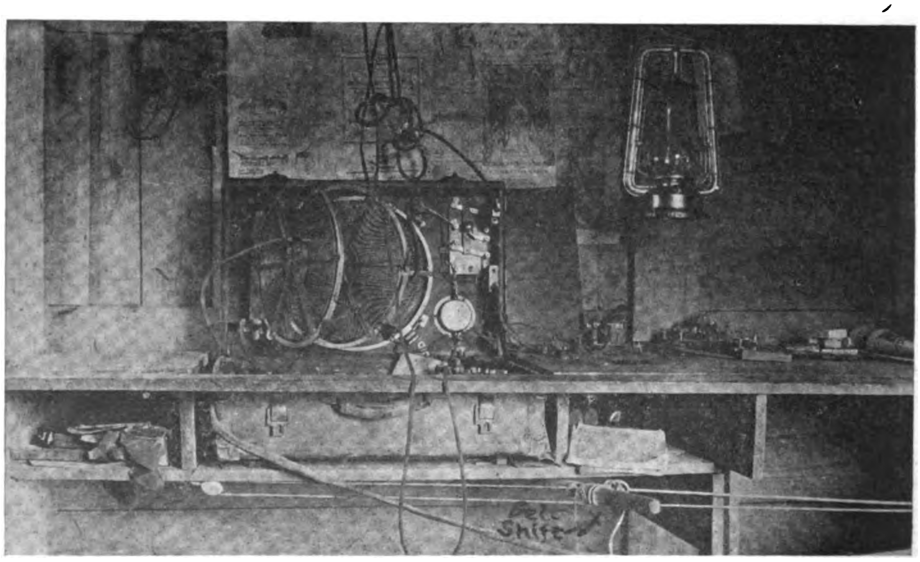
CLOSE observation of the pre-war operations of amateur stations indicates to me that some changes in the methods of licensing are desirable.

I believe the situation can be improved in respect to power input, wave length and licensing of the operator. For example, I would suggest that the owner of a 1-kw. station not in proximity to military or naval stations, be required to hold a second grade commercial license. This would give the assurance that the owner has a far better working knowledge of his apparatus than the average amateur and it is reasonable to assume that he would not misuse the power of his station to create unnecessary interference.

Those unable to qualify for a second grade certificate should be placed in class 7 under the former Radio Laws. In most cases this class includes younger boys who are not interested in the art from a scientific standpoint. I believe your readers will agree with me that this plan will eliminate to a marked degree interference between 200 meter stations.

The owners of stations put in class 7 will thus be given an incentive to improve their ability as an operator and to increase the power and wave of his station.

L. N. WAY—"9XD."



Interior of wireless station at Camp Stewart, El Paso, Tex.

The Layout of the Ideal Amateur Station

SOME of your contributors will undoubtedly state at great length the technical requirements of the ideal amateur station, but I will discuss the matter from the view-point of accessibility of apparatus and ease of operation. Amateurs frequently are at a loss how to go about installing their apparatus in a manner that will fulfill these conditions; and while all of us have other ideas on this subject, my years of experience in radio work leads me to believe that the accompanying drawing gives a plan of an amateur station of the detached instrument type that will work towards all-around efficiency and permit the greatest ease of manipulation.

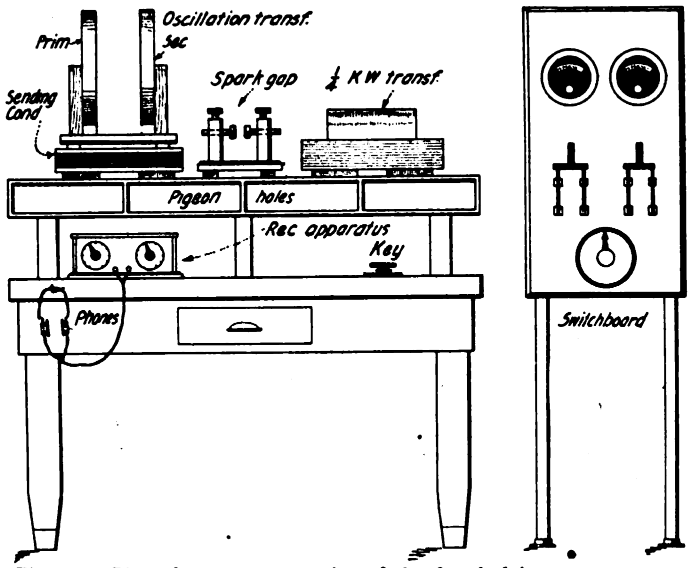


Figure 1—Plan of an amateur station of the detached instrument type

The reader will note that on the top of the pigeon holes which is to retain the message blanks and other stationery, I have mounted the principle elements of the transmitting set, the high voltage transformer, the spark gap and an inductively coupled high frequency oscillation transformer. Immediately to the left of the table is placed an inductively coupled receiving tuner which in the up-to-date station will be fitted with a vacuum tube detector, and at the right the transmitting key in a place convenient to the operator. The switchboard to the extreme right of the table should contain the volt meter and ammeter, a switch for turning on and off the power, and a reactance regulator for controlling the primary current.

This lay-out in addition to presenting a neat appearance permits the shortest possible connections between the elements of the closed oscillation circuit.

The general specifications of the spark transmitter are so well known to the amateur field that we need not enter into a discussion of the problems here. It is believed that if the plan I present is adopted by the rising experimenter, it will prove of great advantage to successful operation.

E. T. Jones—*Louisiana.*

A Plan for Organization

(Continued from page 23.)

regulations prescribed, the rest could be banned and their methods advertised.

The publicity committee, being an important one, should have a capable executive as chairman, the balance of the personnel being selected from members of the other committees, so each division of committee activities would receive its full share of publicity. The State organizations' activities should then be actively covered—and with clocklike regularity—by reports sent to the magazines interested in wireless, provided interesting items were sent to the press regularly.

The subject of raising funds is a pertinent and vital one. Anyone who has had experience with local or State clubs knows how difficult a matter this one is. Ninety per cent of the trouble, however, is due to the fact that service of actual value to the amateur must be rendered if it is expected of him that he continue to pay dues. Numerical membership increases are largely dependent upon the dues being low, yet it is obvious that expenses increase as the membership grows. If dues are placed at a high figure, few care to join and the puropse of the organization—wide mutual benefit—is defeated.

On the State organization proposition it does not seem practical to look for local clubs to contribute out of their treasuries; they are usually long on enthusiasm but short on cash. Local clubs usually have a sufficiency of financial troubles and are not in a position to help out, even if entirely willing to do so. So, for a State organization, an endowment fund seems a necessity. To secure endowments, it is necessary to incorporate under the State laws. A faultless constitution is also necessary; one that financiers will pass upon without question. Two honorary grades of membership should be provided for, to be bestowed on public-spirited citizens who contribute $50 or $100, or more, to the endowment fund. These men need not necessarily be interested in science; the membership and publicity committees should cooperate closely in connecting with and convincing men of means that their support will greatly benefit a body of serious-minded students of the wireless art. Funds can be raised by endowment, if this course is carefully pursued, which will aggregate a sum ample for all expenses to be paid out of the interest received by wise investment of the principal.

Other than the honorary membership, the Association should have two grades for amateurs, the highest (member) to consist of those who secure Commercial 1st Grade licenses, or the equivalent in experience; and a second grade (associates) comprising the beginners in the art who may later develop into candidates for the higher grade. Standards of membership should never be lowered. Exactly what these standards should consist of and the benefits under each grade, should be determined by the board of directors, as conditions vary in States and various parts of the country.

State organizations could render valuable service through the research and development committee carefully investigating all apparatus on the market. Values and costs of amateur equipment should be thoroughly digested for the information of members, particularly newcomers in amateur wireless, and advice on systems best suited to needs and pocketbooks given free of charge. This committee should also report to the central, or national body, fraudulent practices or misrepresented apparatus, so the national body can secure a refund or replacement where poor apparatus has been received by the individual. This plan has been successfully carried out by the N. W. A. and is a valuable service to amateurs.

It is about time to start the ball a-rolling. It is suggested that amateurs begin now to get in touch with as many prominent amateurs as possible and exchange views and formulate plans. In this way the details will be classified when the time comes for State organizations to adopt a platform that, in main essentials, will conform to conditions throughout the country.

I should like to see a thorough discussion of this subject by amateurs in the columns of The Wireless Age.

Ralph Batcher, 9 YI

A High Voltage Storage Battery for the Audion

One of the principal drawbacks of the vacuum valve detector for amateur use is the expense of keeping up the high voltage battery. The constructional details of a storage battery of about 60 volts follows. The battery may be charged from 110 volts A.C. by placing it in series with a 75 watt lamp and a one jar rectifier of the electrolytic type.

For the stand in figure 1, take two boards about 31 x 4 x 3/4 inches and bore in each thirty one-inch holes, in two rows, the holes being one inch apart.

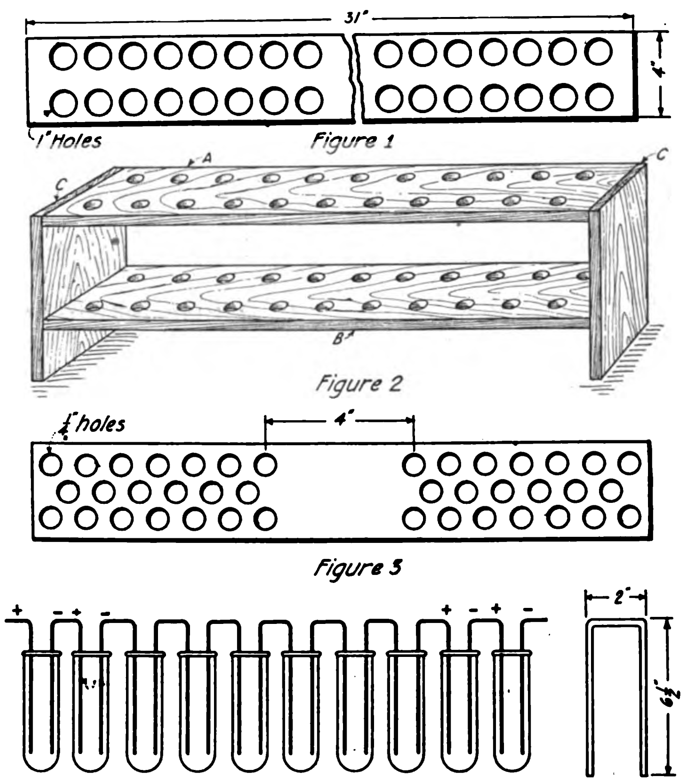
Now take two pieces of wood 8 x 4 x 3/4 inches and by means of one-inch wood screws, complete the stand as in figure 2. The shelf A should be flush with the tops of the end pieces CC, and shelf B should be about four inches below A. The frame should now be well coated with hot paraffine.

Cut thirty pieces of lead 15 x 3/4 x 1/8 inches, and then using a 1/4-inch drill, bore the lead strips full of holes, except for four inches in the middle of each strip as in figure 3.

Next bend the strips as shown in figure 5. Take a little red lead, and make a paste with a 10% solution of C.P. H_2SO_4. In one end of each strip fill the holes with the red lead paste, and in the opposite end of each strip fill the holes with a similarly prepared paste of yellow lead. These form the negative and positive plates, respectively. Two of the strips should be cut in half, these being used at the ends of the two rows.

For the containers use thirty test tubes 1 x 6 inches. Set the test tubes in the rack and place the lead strips in their proper positions, so that a positive and a negative plate are in each tube. (Figure 4.)

Some difficulty may be experienced in keeping the strips of lead an equal distance apart in the tubes. However, this may be overcome by taking pieces of heavy cardboard, previously soaked in silicate of soda and dried, placing them between the plates.



Diagrams showing construction plans of the various parts of the high voltage storage battery

The two rows of cells should be connected in series with a small lead strip.

When this is done, fill each tube to within 1/2 inch from the top with a 20% solution of C.P. H_2SO_4. The tops of the test tubes and the parts of the plates above the electrolyte should be painted with hot paraffine to prevent the acid from creeping.

The battery is now ready for charging and should be connected to a source of direct current of from 65 to 75 volts. The charging rate of this size battery is from 1/2 to 1 ampere, and the capacity is about 2 ampere hours.

Care should be taken to see that the battery is never run down, and that the electrolyte is kept at 1/2 inch from the top of the tubes.

Shelby J. Blong, *California*.

Contest Winners for the February Issue

In response to the call in the November issue for manuscripts concerning the ideal amateur set, prizes have been awarded to the writers of the following articles. The suggestion upon which the contest was based was: "AFTER THE WAR, WHAT IN YOUR OPINION WILL CONSTITUTE THE IDEAL AMATEUR TRANSMITTER AND RECEIVER?"

First Prize—General Specifications of an Ideal Amateur Transmitter and Receiver

THE ideal amateur wireless station should be, if possible, located on the ground floor of a building. If above the first floor, the ground wire may be so long as to cause some loss of radiation. On the other hand, if located in the basement, the lead-in where it enters the building will be too close to the ground and in some cases may cause a serious brush discharge to the earth.

The Aerial

The aerial should consist of six or more stranded copper wires, spaced at least four feet apart. A 10½" hard rubber or bakelite insulator should be placed in the end of each wire. Insulators should be placed every fifteen or twenty feet in the guy wires to prevent loss of current to ground.

Earth Plate

A good earth connection is formed by burying squares of copper or tin sheeting about eight feet beneath the ground, in a circle of fifteen or twenty feet and bringing the connections from the plates in a rat-tail formation to the surface where the ground wire to the apparatus is attached. The ground wire should be at least a No. 4 stranded cable. The plates should be placed flat on the ground as it has been found by several amateurs that they work better than if they are placed on edge.

Power

Care should be taken when wiring the station to run the lighting wires as near right angles to the aerial as possible, to prevent destructive currents from being set up in the power circuits. All wiring should be done in accordance with the underwriters' specifications, which can be obtained from any local electric light company.

The Transformer

The transformer should be both substantial and efficient, and the voltage should approximate 20,000, in order that a small condenser may be used to permit the use of a reasonable amount of power on the 200 meter wave. A transformer with considerable magnetic leakage should be used as it can be adjusted to resonance and will not pull heavily on the lighting circuits.

The Condenser

A good oil-immersed condenser for a ½ to 1 kilowatt transmitter may be constructed as follows: Obtain 10 plates of triple thickness glass each 9" by 12"; coat eight of them on both sides, and two of them on one side each with heavy tinfoil 6" x 9". The lugs and foil are to be cut in one piece. Corners should be rounded to prevent brushing. Shellac can be used for the adhesive, and pieces of fifteen ply cardboard 6" x 9" in size should be placed between the plates for separation, so the oil can get between the plates. Be sure to cut the foil so as to bring the lugs out wherever convenient; then after squaring the plates evenly, tape them together tightly and place them in a box of transformer oil, on their edge, so the oil will force the air-bubbles out between the plates. The box can be made oiltight by pouring boiled sealing-wax along the cracks and letting it harden, then giving it a few coats of shellac.

The Spark Gap

The Marconi type of discharger is simple and efficient. On the shaft of a 1/10 h.p., 3,600 r.p.m. induction motor, mount a 10" "Victor" record with eight equally spaced holes drilled around the periphery about ½" from the edge, large enough to insert a battery binding post bolt. Then obtain some battery binding posts; file off their heads; put them in these holes and fasten them with small nuts on both sides of the disc. The stationary electrodes should be so placed that the rotary plugs will pass between them. This gap gives an excellent tone.

The Oscillation Transformer

The oscillation transformer should be of the "pancake" type with 5 turns of No. 6 and 10 turns of No. 8 copper wire, or 1½" ribbon (copper), for the primary and secondary, respectively. The frame should be made of "Bakelite" or well seasoned wood, and must be constructed so that the primary and secondary windings are accessible to the clips at nearly all points.

All leads connecting together the elements of the closed oscillation circuit should be as short and as heavy as possible. They should have no sharp bends or kinks in them.

THE ANTENNA SWITCH

The antenna switch should be so constructed that when in sending position it connects the aerial to the oscillation transformer; closes the circuit to the current mains and starts the rotary. When receiving, it should connect the receiving tuner to the aerial; open the circuits to the transformer and rotary gap. It should be extremely well insulated; capable of quick and easy operation, and the current carrying parts should be capable of carrying the antenna current without loss.

THE RECEIVING STATION

A long wave regenerative vacuum tube receiver fitted with mica diaphragm telephones and a tubular or other type of bulb should be used. If the set is built into a cabinet, dust can be kept away from the instruments and both the appearance and efficiency improved thereby. Any regenerative connection is good if constructed in accordance with fundamental principles. In place of loading coils for long wave lengths, I have successfully employed condenser units connected across the primary so that one or more may be cut into the circuit. They are just as efficient under some conditions as the loading inductance and take up far less room. A good storage battery should be used to light the filament, because they are more economical in the long run than dry cells.

Every amateur should own a short wave regenerative set as the range is greatly increased when receiving short wave amateur stations. Any of the several types being sold under various trade names may be employed to advantage.

With the above described apparatus the station will be very near present-day amateur perfection.

J. E. LAW, JR., *West Virginia.*

Second Prize—The Ideal Amateur Wireless Station After the War

I SHALL discuss this subject on the basis that the amateur station will be permitted to operate as before the war, i.e., one kw. power input on the two hundred meter wave.

The first and most important part of any wireless station using a short wave, is the aerial. The ideal station should have the aerial supported by a mast at least seventy feet high, if the aerial is near any buildings, trees or wires. Iron pipe masts, wooden towers, or structural steel towers may be used. A very serviceable and satisfactory mast may be constructed of common iron pipe, which may be purchased at any hardware store. By the use of reducing couplings heights up to ninety feet can easily be secured. Some masts over one hundred feet in height have been made, but require a very extensive system of guying and are not easily constructed. Another method is to use wooden 4 by 4's. The transmitting aerial should be seventy-five feet long, and the long wave length receiving aerial two hundred and fifty feet long. The former should be composed of six wires placed three feet apart. The "L" type is preferred. The longer aerial should have at least two wires spaced four feet apart.

The lead-in from the aerials should be composed of the same size wire as the aerials, preferably stranded phosphor-bronze. It should be supported at only one point between the aerial and oscillation transformer. The insulation throughout the aerials should be Electrose insulators. The lead-in may be brought through the wall in a Marconi deck insulator.

The instruments should be five feet or less from the ground connection, which may consist of buried plates, either tin or copper, buried wires or netting, or iron pipes driven in the earth in the form of a circle. In any case the connections should be well soldered. The underground part of the earth plate should extend under the horizontal part of the aerial. The aerial connection should be made directly to the oscillation transformer, the antenna switch breaking only the earth connection.

The oscillation transformer should be made of heavy brass or copper ribbon. The primary should have three turns eleven inches in diameter and the secondary five turns of the same diameter. The transmitting condenser should be made of one-quarter inch plate glass. The plates should be built in a frame and spaced one-quarter inch apart. They should be coated with heavy tin foil, the whole to be immersed in oil. Copper coated Leyden jars may be substituted. A series multiple connection must be employed for potentials above 15,000 volts.

The spark gap may be a rotary, quenched air cooled, or stationary quenched air cooled gap. An efficient non-synchronous rotary gap may be substituted. The transformer should be of the well known ½ to 1 k.w. closed core type. All connections in the closed oscillation circuit should be made of heavy copper or brass ribbon. The key should have heavy silver contacts and a long arm.

The power lines should be protected by micrometer gaps and condensers. Choke coils may be used between the secondary circuit of the transformer, and the condenser. The aerial or antenna switch may be any of the types offered by manufacturers. A marble base is preferred. In selecting a switch the accessibility and efficiency should be considered.

The receiving set should have three

separate tuning transformers. The first for waves from 180 to 600 meters, the second for waves from 600 to 3,000 meters, and the third for waves from 3,000 up to about 15,000 meters. The first should be used in connection with a regenerative circuit. The second is preferably the so-called Navy type, having all variations of inductance made with switches. One turn variation of the primary and ten turns variation of the secondary should be provided for. The secondary should be shunted with a variable condenser. The third transformer is similar to the second, and larger. If large enough only a primary loading inductance is needed, however, very good results may be secured by the use of both "wing" and "grid" inductances with a smaller transformer. All three sets should be used in connection with a good vacuum tube. Any of the types offered are good, although some are more sensitive than others.

The three transformers are used for reception from amateurs and boats, medium long wave spark and arc sets, and long wave arc and spark stations respectively.

In the above specifications a few things have been omitted for separate discussion. The location of the instruments is a very important item for efficient operation. If possible an operating hut should be constructed so as to place the instruments directly under the aerial. This allows short connections which are important. A good hut can easily be constructed by any live amateur.

Another thing to be taken into consideration in the ideal station is the matter of connections. Many different circuits especially for the receiving set have been published. Before making permanent connections different circuits should be tried. Although one gets good results it may be possible to still further improve on them. This applies especially to the long wave receivers.

The transmitter circuit is not susceptible to various connections.. The secondary of the transformer is connected in multiple with the condenser, the gap and primary of the oscillation transformer being in series with the condenser.

An important after the war consideration will be the use of undamped wave sets. However, no details can be furnished at the present time.

The operation of amateur stations, after reopening, promises to be a more dignified proposition than at the time of closing. There will be fewer of the old spark coil "jammers" and only the ones who really mean business will open their stations. Also the fellows who enlisted for Government training will be better operators and consequently erect better stations upon returning. Indeed what we have all wished for is about to take place. Ideal conditions as well as ideal stations will prevail.

Jas. B. Holston, *Illinois.*

Third Prize—Ideal Specifications for a Spark Station

My ideas regarding the ideal radio set may prove of interest to the general type of radio amateur. All component parts of the transmitting set are mounted separately on a suitable sized table—taking particular care to so arrange the apparatus that the leads in the oscillatory circuit are as short as possible.

The condenser is the usual bugbear in the transmitter. It will be given further consideration. The solution of the condenser problem in my opinion is to make it an oil immersed affair—using a good grade of transformer

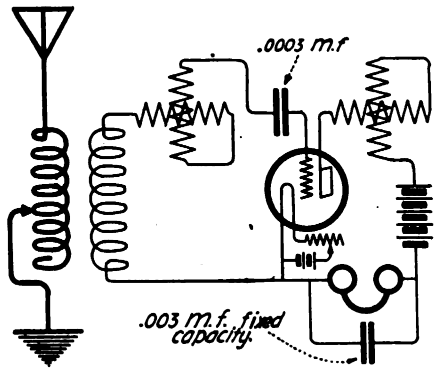


Diagram of the Armstrong circuit for wireless receiving set

oil. If automobile windshield plate glass of ¼ inch thickness is used, little trouble will be experienced as far as "puncturing" of the plates is concerned. Twelve 10″ x 14″ plates in parallel give the correct capacity for 200 meter operation. Tinfoil 8″ x 12″ should be "pasted" onto the glass by putting a few drops of transformer oil on the plates and placing the tinfoil on and squeezing the oil over the surface of the plates with a photographic roller. Then solder copper ribbon at least ½″ wide to the tinfoil.

After each of the 12 plates have been coated they are stacked together and bound with canvas strip. A suitable containing tank should be next obtained. It should be large enough to allow at least one inch clearance around all the edges of the glass plates. Wood strips one inch thick should be placed on the bottom of the tank to keep the plates insulated from it. A bakelite or hard rubber tap should be cut to cover the tank and keep out all dust and moisture.

The rotary gap is the next item. A bakelite disc 10 inches in diameter should be obtained. The thickness should be ⅛″, no more is necessary, and is really harmful, since the lighter

the disc the less the amount of power necessary to turn it. Next 10 brass electrodes are constructed from ¼" threaded brass rod. They should be one inch long, each end finished in a chisel shape with an edge ⅛" thick. Eight of these electrodes should be mounted on the periphery of the disc so that they protrude equally on both sides of the disc and should be held in place by means of a nut on each side of the disc. The stationary electrodes are mounted on brass standards on a marble or bakelite base, one electrode on each side of the disc. The disc itself should be mounted on a polishing lathe, similar to a small jewelers' lathe, which can be bought at any hardware store for the amount of $2.50. I much prefer a belt arrangement such as this type of mounting requires, to the usual method of mounting the disc directly onto the shaft of the motor. One reason is that it allows the speed of the rotor to be more easily changed than the type driven by an induction motor, and another reason is the elimination of the danger of high potentials burning out the winding of the motor. A fan motor or any motor of 1/16 h.p. is entirely suitable for running this gap.

The oscillation transformer is made of 1½ inch brass strip employing the pancake type of winding. The primary is made of 4 turns, the outside diameter of the first turn being 8 inches. The turns should be at least ½ inch apart. The secondary contains 10 turns of similar size. Both primary and secondary are mounted on bakelite strips. The secondary is mounted on a hinge to vary the coupling. Very heavy helix clips should be used.

Any standard make transformer with a secondary potential of at least 15,000 volts is suitable. The Thordarson, 1 kw. 20,000 volt model seems to be the favorite and from a point of efficiency, reliability and cheapness it is the best on the market, in my opinion.

The connections from the secondary to the condenser should be made of, say, No. 24 magnet wire. Two choke coils of No. 24 wire on tubes 2 inches in diameter and 3 inches long are sufficient to take care of all "kick backs" from the condenser.

All connections in the oscillatory circuit should be of very heavy copper sheeting. I buy copper sheet 1/32 inch thick and 6 inches wide in lengths of 2 feet and cut this to the required length with a width of 1½ inches. If all connections in the oscillatory circuit are made as short as possible and the set is tuned by means of a hot wire ammeter and wave meter, no one should experience any great difficulty in working 1,000 miles during the favorable season, provided a modern type of regenerative set is used at the receiver.

Receiving Set

If one cannot afford to buy one of the popular makes of regenerative sets on the market the solution is to construct one. Whether it be mounted in a cabinet or not is optional with the constructor. Personally I prefer to leave mine unmounted so that I can readily adapt the circuit to the various changes that are necessary in order to keep abreast with the times.

The primary of the receiving transformer is 3 inches in diameter wound with 50 turns of No. 24 S.S.C. magnet wire with switches for single turn variation of inductance. The secondary is 2½ inches in diameter, wound for one inch with No. 31 S.S.C., no taps are taken off secondary. The necessary changes of inductance are obtained by using a variometer in series with the secondary. A suitable variometer is described in "How to Conduct a Radio Club." Another variometer of similar size is required in the plate circuit. The diagram of connections is enclosed which is the Armstrong circuit. Brandes Superior telephones fill the bill very satisfactorily.

The aerial should be as high as possible and not over 100 feet long unless it is made of the "T" type, in which case it can be 120 feet long.

The ground connection should be attached to water or gas mains and also to a 4 wire counterpoise buried under the ground for a few inches, parallel and underneath the aerial.

With a transmitting set of the above description, I regularly "put" 8.5 amperes into an aerial 80 feet long and 40 feet high and have as my transmitting record a distance of 1,600 miles.

My receiving record is 1,800 miles with a receiving set similar to the one described having copied 6 EA at Los Angeles, Cal., at Little Rock, Ark., six consecutive nights during the latter part of the 1917 season.

John M. Clayton, *Arkansas.*

Queries Answered

Answers will be given in this department to questions of subscribers, covering the full range of wireless subjects, but only those which relate to the technical phases of the art and which are of general interest to readers will be published here. The subscriber's name and address must be given in all letters and only one side of the paper written on; where diagrams are necessary they must be on a separate sheet and drawn with India ink. Not more than five questions of one reader can be answered in the same issue. To receive attention these rules must be rigidly observed.

Positively no Questions Answered by Mail.

I. H. W., Fire Island, N. Y., writes:

In your December issue I notice an article mentioning that the German station at Nauen, (POZ) could only be heard with a long wave undamped receiver. Nauen now employs a damped transmitter operating at six thousand meters which during the war was used both for sending instructions to submarines and for transmitting press and time signals.

I have copied this station (POZ) on the Marconi type 106 receiver with carborundum detector, without any extra loading coils, up to one thousand miles.

* * *

E. B. L., Sergeant Signal Corps, U. S. Army, writes:

Referring to a brief descriptive item on the Nauen, Germany (POZ), radio installation, printed in the October issue of your valued publication; it may be of interest to you to know that I have been copying matter transmitted from that station, day and night, at all points of our Alaskan itinerary. Their signals are powerful and I copy them with a typewriter, without difficulty. In addition to considering the great distances, a relief map of Alaska will show unusual ore-bearing mountainous obstacles, which, however, appear to affect in no way the amplitude of signals of long wave-lengths. We intercept press matter en-route from Eastern United States, Naval Stations to European stations.

* * *

C. V. H., Kingsley, Kans.:

Ques. (1)—Does it make any difference in which direction the turns on the primary and secondary coils of a receiving tuner are wound?

Ans. (1)—It makes no difference.

* * *

G. S., Gary, Ind.:

Replying to the questions in your recent communication: We would not recommend the use of a 25-cycle alternating current for amateur purposes as the spark frequency will be so low that it will be difficult to read your signals. By the use of a non-synchronous rotary spark gap the spark frequency could be improved, but still the note would partake of the characteristic of the 25-cycle current. The inductance of a high voltage transformer primary constructed for 60-cycles is too low for use at 25-cycles. You could best be informed on the rewinding of this particular transformer by communicating with the manufacturer.

* * *

H. S., Jenks, Okla.:

When the expression "resonance between generator and transformer" in radiotelegraphy is spoken of, reference is made to resonance between the complete transformer and its secondary condenser with the frequency of the alternator. Owing to the close coupling between the primary and secondary coils any change of capacity across the secondary will tune the complete circuit from the alternator through the transformer. An article by H. E. Hallborg in a past issue of the Proceedings of the Institute of Radio Engineers will give you more information on this particular point.

* * *

A. D., Manchester, N. H.:

The natural wave of your "T" type aerial, 120 feet in length and 50 feet in height, is close to 200 meters and with the receiving transformer you have mentioned, the complete system will respond to wave lengths to 4,000 meters.

Keep in mind that the ban on amateur communications has not yet been lifted, but we may expect the removal of these restrictions at an early date.

* * *

S. M. G., Hampton, Conn.:

You may expect in a forthcoming issue of THE WIRELESS AGE complete instructions and working drawings for the design of long distance vacuum tube receiving sets. For a two-stage amplifier, we would suggest that the first tube be connected up with a regenerative coupler for the amplification of radio frequencies. The grid circuit of the second bulb should be connected to the plate circuit of the first bulb by an audio frequency transformer with or without iron core. The loading coil described on page 515 of the April, 1917, issue of THE WIRELESS AGE is applicable for this work. No large gain in efficiency, however, is obtained by the use of multi-layered coils. It is possible to design a receiving set for a range of wave lengths from 5,000 to 12,000 meters wherein the entire range of wave lengths is secured by variation of the variable condensers alone. If you will give us a more complete description of just what type of apparatus you contemplate building, we could give you more definite advice.

If multi-layered coils are employed in receiving circuits, we would advise that the inductance be varied by a multi-point switch. We do not recommend the construction of a universal receiving set to cover wave lengths from 200 to 10,000 meters as it complicates the equipment on account of the necessity for eliminating the unused turns when operating on the shorter range of wave lengths. It would perhaps be simpler to construct two receiving tuners, one for lower range of wave lengths and the other for the higher range.

The method you suggest in question No. 3 for varying the inductance of coils is feasible, but not entirely necessary. You can rest assured that vacuum tubes will be supplied to the amateur market when the ban is lifted.

* * *

W. E. H., Auburndale, N. Y.:

The loading coil to accompany the apparatus described on page 82 in an early edition of "How to Conduct a Radio Club" may be 5½ inches in diameter, 28 to 30 inches in length, wound with No. 22 or 24 S.S.C. wire. If this proves insufficient to attain the wave length of 10,000 meters a small variable condenser may be connected in shunt to the primary winding of your transformer. Regarding the taps on the coils L-2 and L-7: A very wide range of wave lengths may be attained simply by employing a fixed number of turns, the wave length being changed by variable condensers.

Under certain conditions, it may be of advantage to bring taps from the coil. Satisfactory closeness of adjustment can be secured by tapping these coils every two or three inches. The books "How to Conduct a Radio Club" and "Practical Wireless Telegraphy" give numerous diagrams for connecting up transmitting apparatus. A fundamental circuit, for example, appears on page 98 of "Practical Wireless Telegraphy." Use this diagram of connections beginning at the notation marked "generator." You perhaps will not employ the wattmeter or reactance coil shown in the diagram. In the third revised edition of "How to Conduct a Radio Club" on page 39, figure 17 is shown a diagram giving the fundamental amateur circuit. The amateur transmitter you will observe is very simple.

* * *

L. R. D., Kinsale, Va., inquires:

Ques. (1)—Which would be the better aerial for all around receiving work, one consisting of two wires, 200 feet long and 40 feet in height, spaced 6 feet apart; or one 100 feet in length 40 feet in height using 4 wires, spaced 3 feet apart?

Ans. (1)—The smaller aerial would be better for amateur reception, but for long waves either aerial would be suitable. As a matter of fact, considering modern types of vacuum tube receivers, the dimensions of the aerial have little to do with range of reception provided the fundamental wave length of the antenna is not too great to establish resonance with the distant transmitting station. No matter how weak the intensity of the incoming signals, by cascade audio or cascade radio frequency amplification, they can be enormously amplified and brought to audibility.

Ques. (2)—What would be the approximate wave length of this aerial?

Ans. (2)—The 200-foot aerial has, approximately, a natural wave length of 335 meters and the 100-foot aerial approximately 165 meters.

Ques. (3)—Please advise the correct hook-up for the attached diagram of connections for galena and silicon crystal detectors.

Ans. (3)—Much better response can be received from distant transmitting stations by shunting the head telephone around the fixed condenser which in your diagram is marked "FC." Otherwise the diagram is correct.

* * *

H. S., Jenks, Okla., inquires:

Ques. (1)—What type arc transmitter does Nauen, Germany employ?

Ans. (1)—We have no knowledge that an arc transmitter is in use at this station. We understand that it is equipped with an 8,000 cycle alternator, the frequency of which is increased to 16,000 by a set of frequency changers. The Nauen station is also equipped with spark apparatus but we have no information regarding the power or the design of the set.

Ques. (2)—How does the von Lepel type of transmitter compare with the ordinary spark system in respect to range and efficiency?

Ans. (2)—We have no definite data on the efficiency and range of this apparatus as compared with other systems. Ship sets have a transmitting range of about 300 miles. Only a very few installations of the von Lepel system have been made.

Ques. (3)—Where can I obtain data on the construction, operation and efficiency of the von Lepel ½ kw. set?

Ans. (3)—A brief description of the Lepel system is given on page 688 of the third edition of the "Principles of Electric Wave Telegraphy and Telephony," by J. A. Fleming. Page 193 of the second edition of Dr. Eccles "Hand Book of Wireless Telegraphy and Telephony" gives some details regarding the system. The only important feature regarding the design of the Lepel transmitters is the arc gap which is sometimes called a quenched arc. It is described briefly in Fleming's text above mentioned.

The von Lepel discharger produces damped oscillations at rates above audibility and hence for telephonic reception these oscillations must be modified to an audio frequency. This is usually effected by shunting the arc with an audio frequency circuit as well as the usual radio frequency circuit, which causes the arc to oscillate at a radio and audio frequency simultaneously when the key is closed. In this way groups of damped oscillations are induced in the antenna circuit. If you will refer to pages 212, 213, 214 and 215 of the "Hand Book of Wireless Telegraphy" by James Erskine-Murray, you will obtain further details regarding the Lepel system.

* * *

Corp. G. M., Fort Sill, Okla.:

Ques. (1)—Can an arc transmitter be operated from a 110-volt 60-cycle current? If so, please give connections of the apparatus.

Ans. (1)—An arc set operated by alternating current would produce damped oscillations and is inefficient. However, it is possible to use alternating current in a semi-arc system such as is described on pages 68 and 69 of Dr. Goldsmith's "Radio Telephony."

Ques. (2)—Why is it that an induction coil will not operate on 110 volts even when there is an incandescent light in series with the primary winding?

Ans. (2)—The inductance of the primary winding of the induction coil may be too low or too high for use with alternating current. The design for an induction coil for interrupted direct current is distinctly different than for an open core alternating current transformer. Now and then one comes across an induction coil which may be used on either alternating or direct current provided a series resistance or a series reactance is employed to regulate the primary current.

With an incandescent light in series with the primary winding of your induction coil the flow of current is governed by lamp, and if the lamp passes but ½ ampere, the primary current is too low to produce an appreciable effect on the secondary.

* * *

A. R., Scottsville, Mich.:

It is considered the better procedure to "bunch" the lead-in wires beginning a few feet from the flat-top portion of the antenna down to the lead-in insulator in the wireless cabin.

The international signal PRB is an intimation to the receiving operator on the part of the transmitting operator that he will use the International code of flag signals in his radiograms. These, of course, are transmitted by radio and not by flags.

The sales price of vacuum tube transmitters can be obtained from the Commercial Department of the Marconi Wireless Telegraph Co. of America, 233 Broadway, New York City. Either alternating or direct current may be employed in connection with the transmitting tube. If alternating current is used it must be rectified for the plate circuit. Alternating current may be used to light the filament. The voltage of the filament battery may vary from 6 to 110 volts and the plate voltage from 150 to 8,000 volts, according to the design of the tube.

Radio Telegraph and Telephone Signal System

A WIRELESS telegraph and telephone system described by August J. Kloneck is shown in the accompanying drawing, figure 1. In the diagram the numeral I is a source of alternating current which furnishes power for the motor generator 2, the motors 3 and 4 of the high frequency generator 5 and the motors 6 and 7 of the rotary spark gap 8.

In operation, current from the generator 2 flows through the wire 10 to the receptacle 11 of a transmitter valve 9 which contains a suitable liquid such as mercury. An electrical circuit is completed through the opening 12, with the mercury of receptacle 13, through the opening 14 of the auxiliary spark gap shown at 8, which works on the vernier principle. For example, if the disc 22 has 9 points and the disc 23, 11 points, then the frequency of the current for one revolution will be 9 x 11. This arrangement permits any desired number of oscillations by varying the number of spark points upon each disc.

The current from the armature of the alternator flows through collector rings 25 and 26 which are attached upon the shaft 27. Brushes 28 and 29 serve to conduct the current from the rings to the terminals of the generator. One terminal is connected through wire 32 to a conductor ring 33 and disc 22, through the spark gap

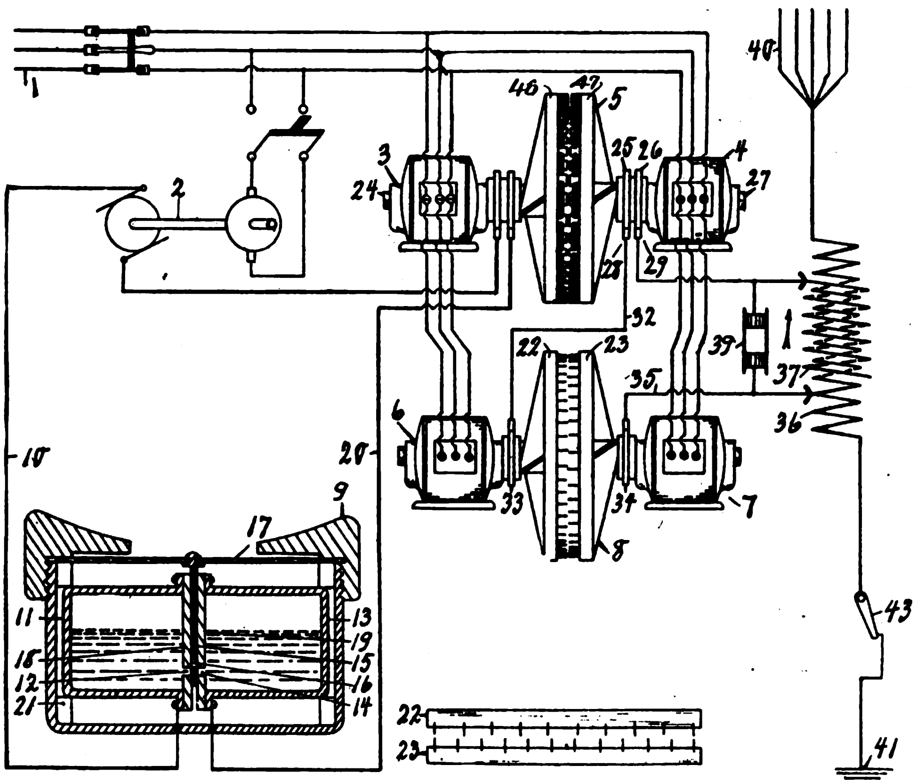


Figure 1.—Plan of construction and diagram of connections of the radio signaling system.

iary receptacle and the port 16 of slide valve 15. The valve is rigidly secured to the disc 17, which is in reality the diaphragm of a telephone transmitter. Variations of the diaphragm as usual cause a varying speech current to flow through the transmitter and thereby varies the field current of the high frequency alternator 5.

The field of the generator 46 and the armature 47 are attached to shafts 25 and 27 of the motors 3 and 4, which can be substituted by high speed turbines. They are rotated oppositely, producing current of very high frequency.

The frequency of the current is further increased through the special ro- to the disc 23 and ring 34, and through wire 35 to the coil 36 of a spark gap transformer. The current from the second terminal of the generator 5 flows directly to the coil 37 of the spark gap transformer. As will be seen in the illustration, each terminal of the generator 5 is connected with a coil of the spark gap transformer, or the coils 36 and 37, respectively.

It is convenient to have one disc movable in respect to the other in order that the spark distance may be varied. For the purpose of preventing the development of higher voltages an adjustable spark gap 39 shunted across oscillation transformer is provided.

The Attack on the Alexander Bill

(*Continued from Page* 30.)

Paul F. Godley appeared for the amateur on the last day of the hearing. He stated that he represented the Radio Club of America and that in executive session its Board of Directors originally concluded that the amateurs would be satisfactorily and sufficiently represented by Mr. Maxim. But developments since then had made it appear advantageous to clear the atmosphere as it concerned the radio amateur. "The Radio Club of America wishes to go on record as firmly opposed to the bill now before this committee," stated Mr. Godley.

He gave as a reason for this decision, that regulation under the present law and the Department of Commerce had been entirely satisfactory to both amateur and commercial interests, and fair to these and the Navy.

A decidedly greater sense of security would be felt by the amateur under the Department of Commerce, was Mr. Godley's conclusion, because experience has shown "that that department can and does give him a square deal," the amateur's representations being given consideration on an equality basis with those of commercial and governmental stations.

Mr. Godley then asked the congressmen to consider the subject from the standpoint of the inventor. "Whether he knows it or not, every serious amateur is potentially and at heart an inventor," he asserted. "As an inventor, it is decidedly to his interest to do everything in his power to prevent the monopoly of radio by the Navy.

In conclusion, Mr. Godley offered in the name of his club certain recommendations, "should this bill, against the wishes of the amateur, be passed in any form." These were, briefly, a license requirement of 60 letters per minute; receiving stations, but not their operators to be licensed; a general restriction to 250 meters, except in special cases, and no geographical limitation on power excepting within 5 miles of a naval receiving station; that power restrictions remain as defined by the law of 1912, pending a national conference of amateur radio organizations to determine a policy.

In a rebuttal statement, Captain Todd, Director of Naval Communication, said that the hearings had apparently demonstrated how difficult it would be for amateurs to agree among themselves, attempts to get together, he had been told, meeting with very poor success.

Congressman Green took exception to this statement. He illuminated the difficulties of the few present to undertake agreement for the large number who did not come to Washington. But, even so, no great lack of unanimity or agreement appeared in the conversations he had held. "They were largely against it," he stated, "and some of them very fiercely against it." Those who had not been satisfied with explanations of the bill and amendments had said, "that they could not undertake to subscribe to an agreement without conferring with some of the vast number of men engaged in the radio art; it would have been ridiculous for them to have undertaken to bind other people without conferring with them."

Captain Todd said that his point was, it was just as well that the Navy did not try in the beginning to incorporate in the bill anything that would please the entire number of amateurs. "From the earnestness with which the amateurs talked," he added, "I think it probable that you (the Congressional Committee) will pay considerable attention to them."

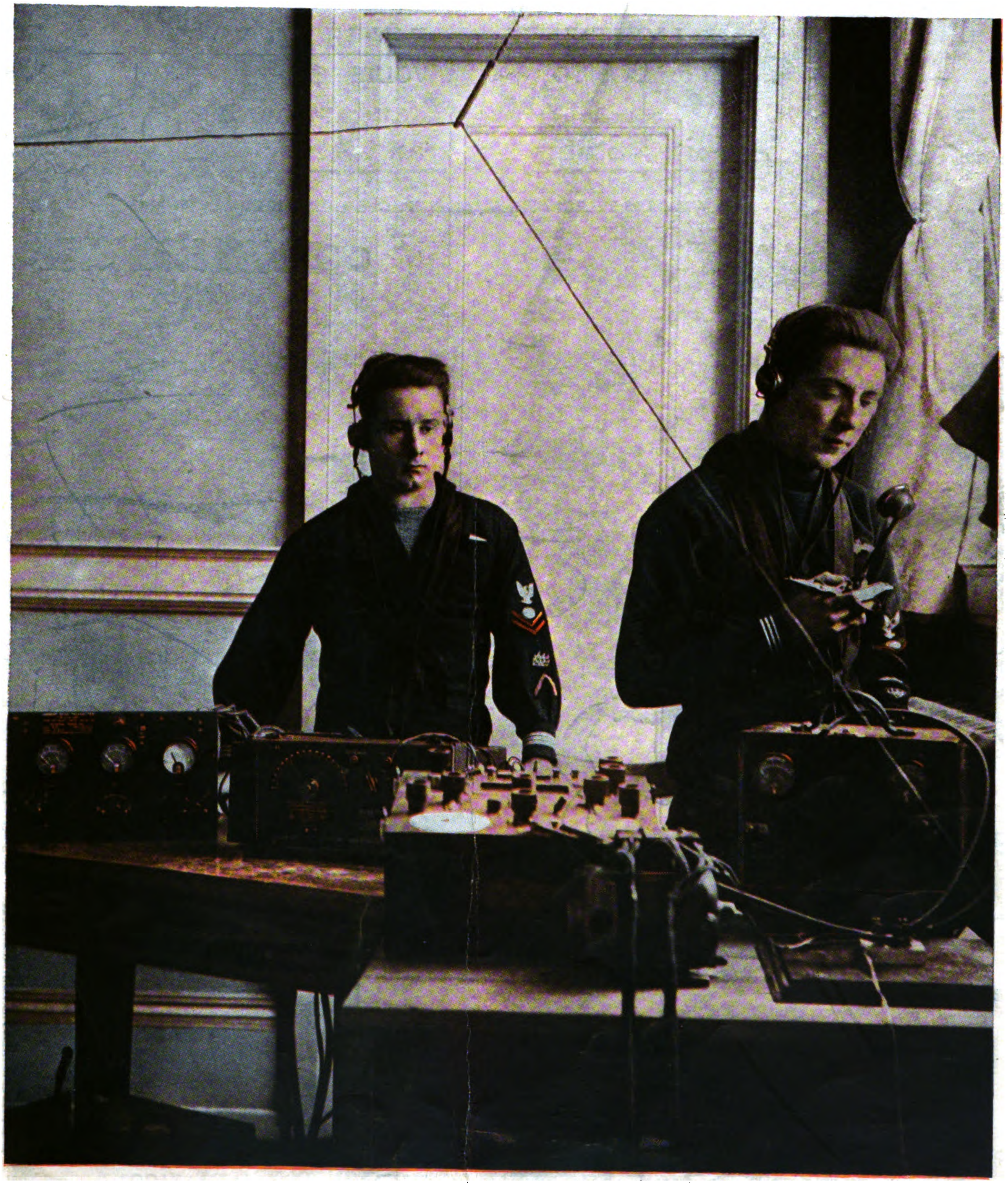
The hearings closed a few minutes later, at 6 p. m. of December 19. On January 16, by unanimous vote, the committee laid the bill on the table, without a dissenting vote on the resolution to that effect offered by Congressman Bankhead of Alabama.

March, 1919

20 Cents

The WIRELESS AGE

Volume 6 Number 6

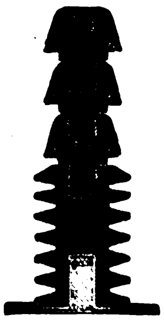


Directing Aircraft By Wireless Telephone

Views For and Against Gove

BUY WAR SAVINGS STAMPS

FOR ALL THERE IS IN IT!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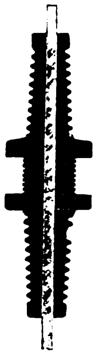
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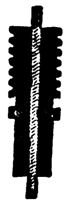
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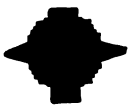
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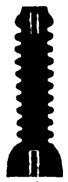
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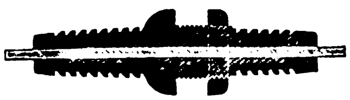
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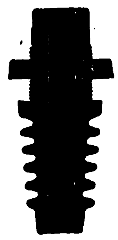
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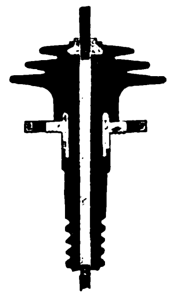
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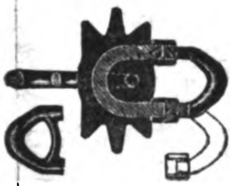
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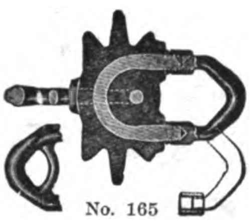
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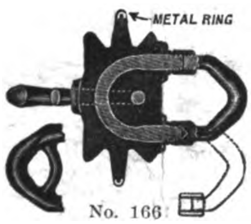

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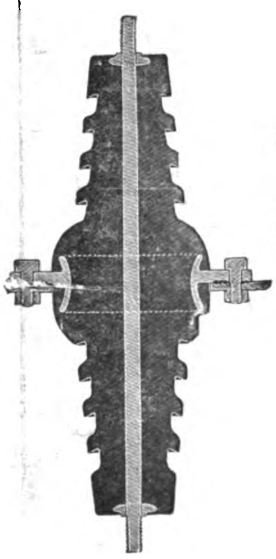
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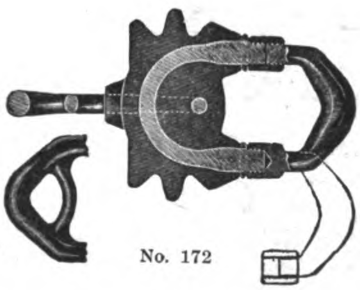
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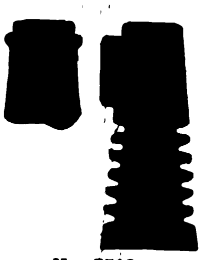
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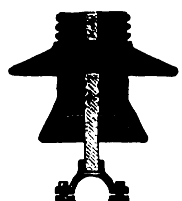
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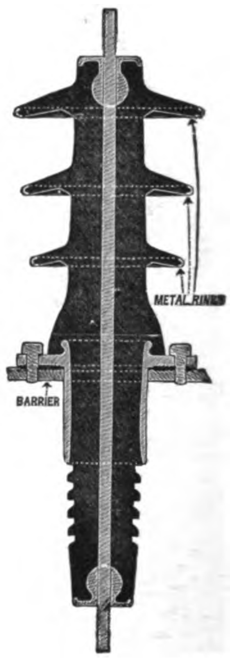

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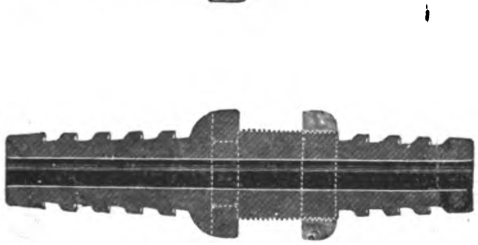
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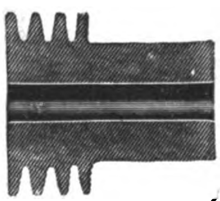
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The Wireless Age

Edited by J. ANDREW WHITE
E. E. BUCHER, Technical Editor

Vol. 6 **Contents for March, 1919** No. 6

Index of Equipment

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GREAT BRITAIN
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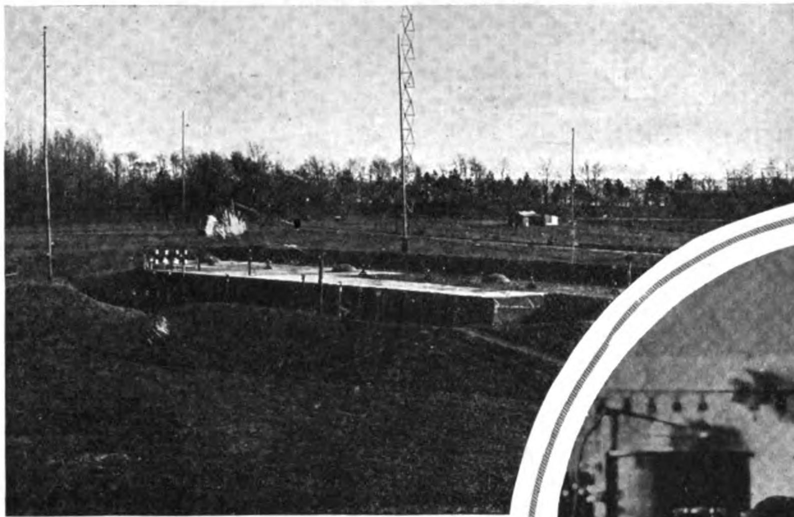
AUSTRALIA
97 Clarence St., Sydney, N. S. W.

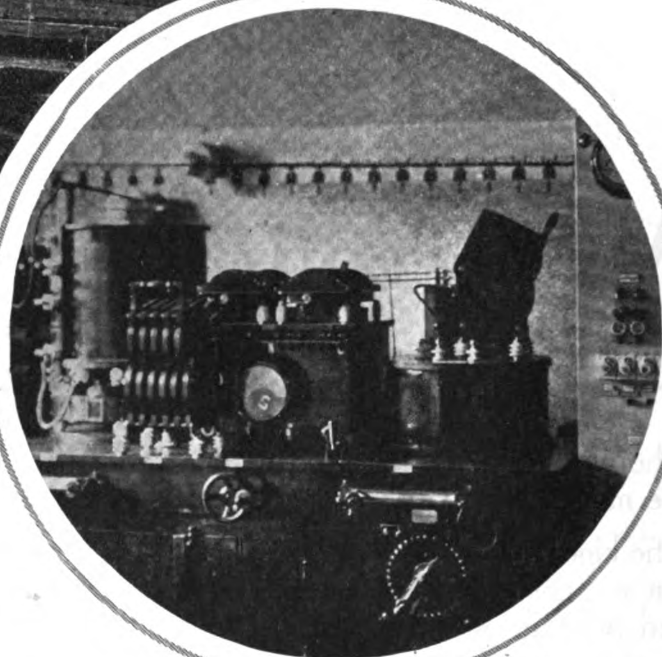
French Official Photos

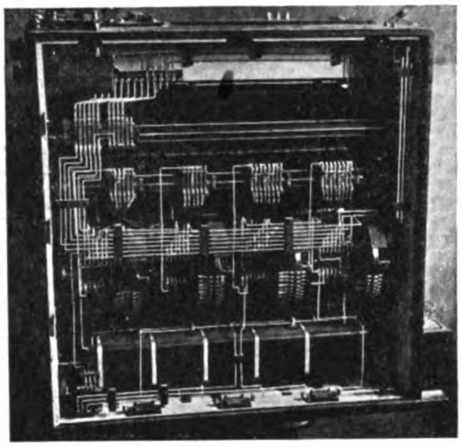
Metz

Taken from the Hun

To the left, a general view of the powerful wireless station maintained underground at the stronghold at Metz, delivered to the Allies under the armistice terms

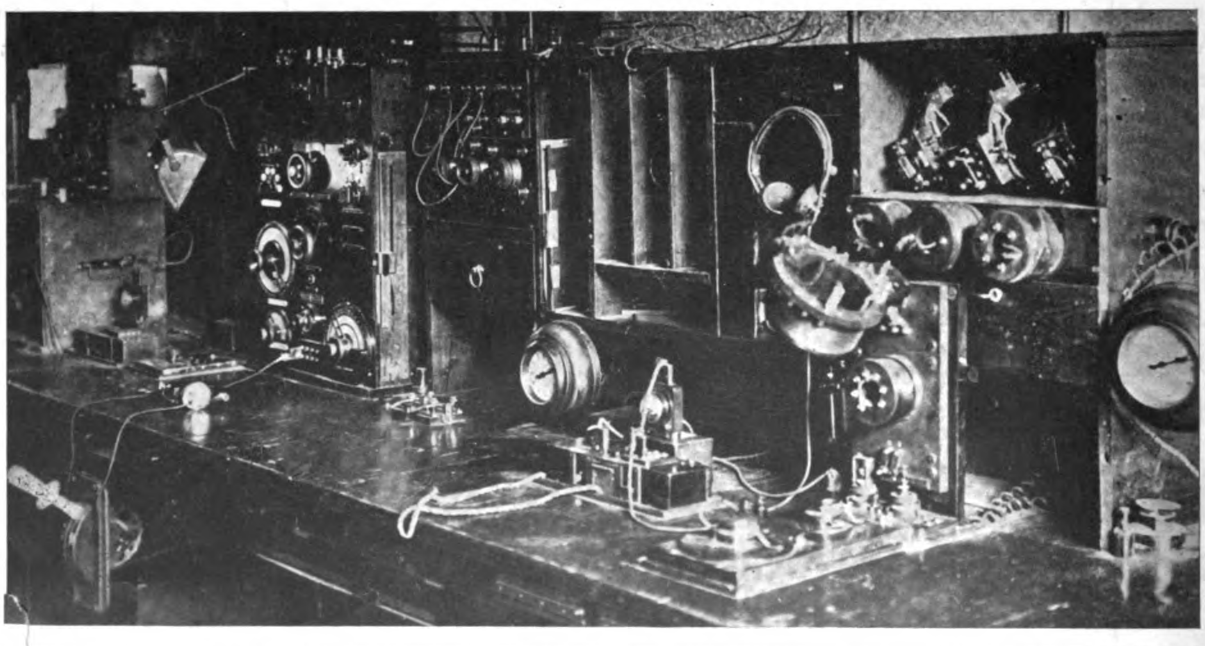






Above, in circle, the transmitting apparatus which was hooked up to the antenna on the 85-meter tower shown in the upper view

To the left, the receiving tuner with the front cover removed, revealing the elaborate mechanism for changing to the numerous wave lengths used for secrecy in transmission



The operating table with a typically German multiplicity of tuning appliances

VOL. 6. No. 6. MARCH, 1919

THE WIRELESS AGE

WORLD WIDE WIRELESS

Blimp Flying Over N. Y. Directed by Wireless Phone

A DEMONSTRATION in directing aircraft by radio telephone was given on January 17th from the roof of the Equitable Building, New York. It was arranged by the navy as a feature of the opening of the $2,000,000,000 War Savings Stamp campaign. The radio communication was between a group of men on the roof of the Equitable Building and Navy Dirigible A242, escorted by a formation of airplanes from the Rockaway Station. The airship, commanded by Ensign John Benridge, cruised over the city for about half an hour, following the directions given by wireless telephone. The weather was thick and the machines appeared at an altitude of about 1,000 feet.

James S. Alexander, President of the National Bank of Commerce, was the first of the civilians present to communicate with the airship. He got into touch with Ensign Bark, the radio man on the dirigible, after the navy operators had made the necessary adjustments. At that time the weather was so thick that the aircraft could not be seen. Mr. Alexander inquired when they would come into sight, and almost while he was talking the formation came through the mist.

"You will circle about the Woolworth Building," directed Mr. Alexander. The Blimp almost immediately changed her course, and headed to execute the order. This accomplished it carried out other spoken orders from the group on the housetop. Mr. Alexander said Ensign Bark's brief replies had been quite distinct. He had requested the Ensign to speak slowly and distinctly, and when this was done he heard every word clearly.

Others who conversed with the operator on the airship as it circled over the lower part of the city were George T. Wilson, Major General Thomas H. Barry, Major General Davis C. Shanks, Guy Emerson, Vernon Munroe and A. M. Anderson.

New Stations for Mexico and Nicaragua

A DAILY NEWSPAPER of Managua states that a Mexican gunboat is soon expected to arrive at Corinto with material for the installation of a wireless telegraph station presented by the Government of Mexico to that of Nicaragua. The wireless station is to be of the same power as the one given by the Government of Mexico to the Government of Salvador. The same vessel will also bring the Charge d'Affaires of the Mexican Government, near the Government of Nicaragua. With the members of the Mexican legation in Nicaragua is a detachment of Mexican marines who will accompany the party into the interior for the purpose of presenting to the President the wireless station referred to.

It is further stated that in Mexico a wireless telegraph station was recently established at Pungarabato, State of Guerrero, powerful enough to communicate with the stations at Chapultepec, Acapulco, and other distant points of the Republic.

British Marconi Company Declares Dividends

THE directors of Marconi's Wireless Telegraph Co., Ltd. (British corporation) have decided to pay a dividend of 7 per cent, less income tax, on the preference shares and a dividend of 5 per cent, less income tax, on the ordinary shares, both dividends on account of the year ended December 31 last.

Photo Paul Thompson

Radio telephone test in New York consisting of the direction of aircraft, conducted by Major General D. C. Shanks and General Thomas Barry

Navy Protests Tuckerton Tax Value

THE United States Navy, which has control of the Tuckerton Radio Station, has appealed from the assessment of $400,000 on the property, fixed by the County Board of Taxation, and has asked its reduction to $225,000. The board has granted naval officers time to file an inventory.

The station was built by a German company in which the Kaiser was said to be a heavy stockholder. It was subsidized by the German government and exploited at the time as having cost two millions. Conservative investigators concluded that the two millions were marks, which would make the cost $500,000.

The station was seized by the United States in the summer of 1916, and has since been in charge of the Navy Department and is guarded by 500 marines.

Shipping Growth Requires Call Letter Expansion

A CURIOUS illustration of the fact that growth of the American merchant fleet is greater than experts believed would be possible is afforded by inadequacy of the radio call code. The allotment of alphabetical call letters has been upset by additions made to American shipping. To the United States were assigned combinations from KDA to KZZ, all beginning with N and all beginning with W.

The American merchant marine has reached such proportion that supply of calls alloted to the United States has been exhausted, and many four letter calls have been adopted as a makeshift. A commission on interallied radio communication will meet in Paris to consider revisions of the code and other important post-war problems.

The powers of this commission will be limited to recommendations. Radio reform can be accomplished only by a more representative body, the International Radiotelegraphic Conference, which should have met in Washington in 1916, but was prevented by the war.

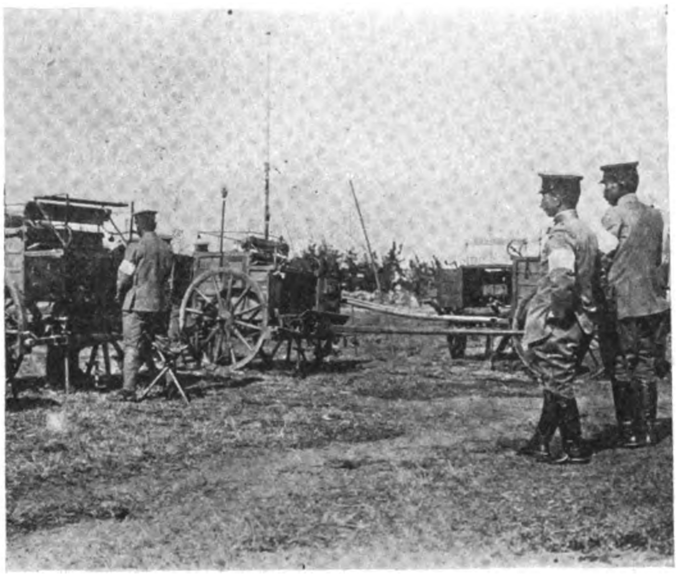


Photo Press Ils. Svce.

Japanese wireless station of the field cart type which shows the similarity with U. S. Army equipments

Distress Call Wirelessed When Fire Puts Out Beacon

A RECENT fire partially destroyed Execution Lighthouse and burned its machinery, leaving the station without power to flash its signal and operate its foghorn. The lighthouse is located between New Rochelle and Sands Point, N. Y., and with the Sound shrouded at night in a heavy fog, several naval craft were sent to patrol in the vicinity and warn vessels of dangerous rocks.

A wireless calling for aid was sent out by Peter Forget, keeper of the lighthouse. It was picked up at Police Headquarters in New York City, and a fireboat was immediately despatched to Forget's assistance. The Navy Department also sent vessels, and four launches filled with soldiers put out from Fort Slocum.

The fire started in a wooden shed and quickly spread to the generating plant. Because of the fog the blaze was not seen from the shore until it was at its height.

It will take several days to install new machinery, and in the meantime the naval craft will remain off Execution Rocks.

New Commercial Wireless Service for Airplanes

FURTHER details of the scheme for supplying Marconi service to airplanes, announced in the February issue, are now at hand. From London, word has been received that Godfrey Isaacs, managing director of Marconi's Wireless Telegraph Co., Ltd., has made public some of the arrangements made in connection with a new organization for the development of air service for passengers, mails, parcels post, and parcels delivery for even larger goods.

The service will commence in the United Kingdom and the Continent, but will later develop to all parts of the world. A measure of safety is going to play an important part in the rapidity with which the services are developed, and it must be apparent that safety will be increased by the assistance of wireless and a thorough and complete organization for its effective use.

The company will be prepared to supply every airplane with a combined wireless and telegraph installation, and to supply with it an efficient and thoroughly qualified operator, adopting the same system as is in force with regard to ships—namely, keeping the apparatus up-to-date, maintaining it in perfect working condition, and supplying the operator at a combined charge rate per annum.

They will issue charts giving the exact position of a number of their stations in all parts of the world, and these will be furnished with direction-finders, which will show to the operator the exact position of the airplane wherever it may be. There will also be charts issued dividing the air into zones, each of which will be numbered. They will at given periods send out air reports and in return will receive air reports. Record charts will be issued from time to time showing these reports, which will serve as comparisons of disturbances in the air, and will furnish valuable information for the guidance of pilots.

Russian Station Connects with France

OMSK, in which are centered the hopes for the rebuilding of a new Russia, after months of isolation, is now actively in wireless communication with the outside world. Hourly reports, containing a complete news service, are received in Omsk direct from the French wireless station at Lyons, France. Outgoing communication will be inaugurated soon.

The wireless tower which dominates the city is the result of the enterprise of M. Nettenent, a Frenchman, formerly consul in New York. In company with a wireless expert and a number of compatriots Nettenent brought the material on a perilous journey from Archangel across the Kara (Black) Sea to the Gulf of Obi. The material was then brought down the Obi and Irtish rivers to Omsk.

From Omsk to Lyons is 3,000 miles on a direct air line over Bolshevik Russia and Central Europe. Omsk is about midway between the Atlantic and Pacific oceans.

German High-Power Station for Dutch

DETAILS of the giant wireless telegraph station to be erected in Holland by German interests for the purpose of facilitating communication between Holland and her East Indian possessions, according to a contract concluded September 23 between the Dutch government and the Telefunken Company of Berlin, are found in a recent issue of Commerce Reports.

Paul L. Edwards, Commercial Attaché at The Hague, reports that the receiving station of the new plant, which is expected to cost about $2,000,000, will be at Boxmeer, in the Province of North Brabant, and the sending station will be located on a hill at Kootwijk, Province of Gelderland, near Apeldoorn, some thirty-five miles from the receiving station. The sending station will consist of six steel towers, each 210 meters (about 688 feet) in height. The Radio-Nieuws says that the Kootwijk sending station will have the same reach as the German station at Nauen. The installation will be able easily to transmit to and receive from a station of like dimensions and capacity which is shortly to be built at Bandoeng, Java. The dis-

tance between the Kootwijk and the Bandoeng station is about 6,830 miles.

It is understood that an engineer representing the Telefunken Company is in Java with a view to supervising the construction of the station at Bandoeng. De Nieuwe Courant said some time ago that all of the apparatus and raw material for the construction of the Bandoeng station were in Berlin ready for shipment at the first opportunity. The apparatus for the station in the Netherlands is not yet completed, but parts are already said to be arriving from Germany.

Standardization of Wireless Before Interallied Conference

IMPORTANT problems involved in the standardization and maintenance of radio communication the world over will be taken by the provisional interallied communication conference which convened in Paris January 25. Under the shadow of the greater peace conference this organization will take up a series of questions relating to radio communication between the allied powers.

The United States Navy representatives are Admiral W. H. G. Bullard, formerly director of naval communications; Captain D. W. Todd, present director of naval communications; Commander M. F. Draemel, in charge of the code and signal section of the naval communication service; Lieutenant Commander E. G. Blakeslee, communication officer on the staff of Admiral Sims; Lieutenant Commander H. P. Le Clair, formerly head of the radio division of the Bureau of Steam Engineering, now radio material officer on the staff of Admiral Sims, and Lieutenant T. A. M. Craven, of the office of the director of naval communications. In the absence of Captain Todd, Commander E. B. Woodworth is acting as director of naval communications.

At this conference all of the allied governments are to be represented and questions of the utmost importance will be discussed concerning the wave lengths to be employed by high-power radio stations, automatic transmission and reception of radio messages at high speed, the call letters to be used for radio communications, the relation of high-power radio telegraphy to the cable situation, and various other matters concerning the transmission of intelligence between the allied countries.

Its primary purpose is to standardize radio communication, and to facilitate the exchange of views relative to the advancement of the art of radio communication for the purpose of insuring the safety of vessels at sea and of serving the needs of commerce in general.

It is possible that the commission may make recommendations to the next International Radiotelegraphic Conference, a meetng of which was called for in Washington in 1916 but was postponed on account of the war. This is a larger body than the provisional interallied communication commission, as it is composed of delegates of virtually all the countries of the world.

Beatty Used Wireless Instead of Guns

THE following are three wireless messages typical of those that Admiral Beatty has been sending across the seas to Kiel these last few days, according to the London Daily Mail.

"Request you will report on sinking of U-93, as same appeared avoidable."

"Torpedoes you failed to send with latest convoy of submarines you will forward by next transport."

"You will stop using your wireless till further orders."

Few who were up with the Grand Fleet for the recent surrender have returned without reverence for the whole attitude and bearing of the British Commander in Chief.

Deprived of his Trafalgar, Beatty has been sending wireless broadside after broadside into the Huns. Said a commander at Rosyth, "They are eating the dirt thrown them by Beatty."

Daniels Acknowledges World's Debt to Marconi

THE part Italy played in the war was warmly praised by Josephus Daniels, Secretary of the Navy; Charles E. Hughes, and Major Fiorello La Guardia, U. S. A., at a meeting held January 26 at the Metropolitan Opera House, New York, under the auspices of the Italy-America Society.

Secretary Daniels said in part:

"I wish today to express the obligations which this republic, which the people of every nation, feel particularly to the naval constructors of Italy, for the contributions they have made which have revolutionized naval warfare.

Photo Intern'l

Speculation on communication with Mars and the successful installation of wireless service between England and Australia by Marconi has again attracted world-wide attention to him

"Nor do we forget the debt the world owes to Marconi, who caused the electric spark to leap at the bidding of man and not to be tied to the cable, so that men on ships speak to each other not hundreds of miles apart, but thousands, and space, so far as communication between man and man is concerned, has been annihilated."

Inter-Stellar Wireless a Possibility to Marconi

IN an interview which Harold Begbie, a representative of the London Chronicle, had with him, Marconi discussed the possibility of communicating by wireless "with the stars"—that is, bodies in our own or other solar systems on which there are intelligences.

When asked if he thought the waves of ether were

eternal, Mr. Marconi replied: "Yes, I do. Messages that I sent off ten years ago have not yet reached some of the nearest stars. When they arrive there, why should they stop? It is like an attempt to express one-third as a decimal fraction; you can go on forever without coming to any sign of an end. That is what makes me hope for a very big thing in the future." (Communication with intelligence of other celestial bodies.) "It may some day be possible, and as many of the planets are much older than ours the beings who live there ought to have information for us of enormous value. It is silly to say that other planets are uninhabited because they have no atmosphere or are so hot or are so different from the earth. If there were no fish in the sea we should say life there is impossible, and so it is impossible for man." When the interviewer objected that the language difficulty seemed to present an obstacle impossible to surmount, Mr. Marconi replied: "Well, it is an obstacle, but I don't think it is insurmountable. You see, one might get through some such message as 2 plus 2 equals 4, and go on repeating it until an answer came back signifying 'Yes,' which would be one word. Mathematics must be the same throughout the physical universe. By sticking to mathematics over a number of years one might come to speech. It is certainly possible." Mr. Marconi stopped speaking for a moment, and then, as if the matter was something so uncertain that he did not feel it worthy of more than passing mention, said he had often received strong signals out of the ether which seemed to come from some place outside the earth and which might conceivably have proceeded from the stars.

Wireless Stages the World Drama

WHAT appears to be inside "dope" on the radio communication incidents that dramatized the receipt of the news of Germany's surrender is contained in a description from Guy Hickok, of the Eagle Bureau, Paris. He writes:

"A group of lads in olive drab sat in an American wireless receiving station not far from Paris.

"It was a long evening in the early part of last November. The man with the headpiece pinching his ears was thinking of the old days when baseball scores used to click into his little wireless house on board a big fruit-carrying ship. He listened absently to the calls ripping the atmosphere with code that he didn't understand. He had to listen, for no one knew when there might come whispering out of the sky a message that he could understand, a message that he was stationed there for the sole purpose of receiving.

"Suddenly the zip-zip-zipzip of the receiver ceased being a meaningless succession of whispers without sense. It dropped from code to simple speech. It—he listened for awhile—it was incredible. He turned to the others, his face contorted with the effort to believe the unbelievable.

" 'Good—! Good-God! It's Germany talking to Foch!' he cried in a strained voice.

"A small shower of cigarette stumps shot into the corner of the room. Every lad in the tiny place sprang up and leaned over the table. It was a long time before any of them moved away—for what they heard there, what they saw the man with the steel bands around his head scribble on the paper they slid under his hand, was one of the most dramatic events in the history of the world.

"Some day this moment of history will be fully written. As these American boys heard it, the tremendous import of the moment was so overpowering that they could scarcely realize what they were hearing. Fragment by fragment the truth dawned upon them.

"Erzberger—yes, Mathias Erzberger—was talking to Allied Great Headquarters —talking about an armistice. It was the first hint of such a thing. Talking about cessation of hostilities.

"It was not very clear. And there were confusing interruptions. For a time both of the great German sending stations were talking at once. Erzberger was speaking from the Berlin station. And somebody—somebody who hated talk of armistices—was 'jamming the air' from the German station at Nauen. For a time it seemed doubtful if Erzberger would ever get anything said. For the Nauen station would always begin stuttering in time to break up the sense of his sentences.

"At last Nauen relapsed into silence, and what had sounded like a three-cornered backyard wrangle straightened itself out into the magic talk that ended four years of horror.

"But before even the beginning of an agreement was reached another wireless voice interrupted: It was a British ship of war and it wanted to know what was up.

"A deeper British wireless throat broke in and told the first to keep silent.

"Another whisper from the sea, American this time, queried insistently, demanding to know a lot of things. And another command, identified as from the American flagship in European waters, hushed the query.

Pieced Fragments Spell Victory

"It was a long time unraveling. It came in fragments, half statements—like actual dialogue at a great crisis.

"Erzberger, talking for Germany, wanted armistice discussions opened. Another faction, that in possession of the German wireless at Nauen, would rather eat nails *au natural* than talk any kind of peace. Allied headquarters were meticulous. They were not going to snap up any old appeal for an armistice that came along. It had to be a *bona fide* one bound by all kinds of guarantees before they would even glance at it.

"After a period of getting nowhere Erzberger asked permission to talk to the German army chiefs in code. Permission was peremptorily refused.

"There followed a pause, after which Erzberger sent eight long messages, not in code, each of which was answered from German army headquarters by one word.

"Conversation with Allied headquarters began again. This time brass tacks became much more apparent than hitherto.

"They began dickering over the actual means of bringing about a conference of envoys. Germany wanted to send them over the Allied lines in airplanes. Oh, airplanes plainly marked with proper identification of course.

"But Allied chiefs wouldn't have it. No German airplane was coming over their lines with their consent. Immunity would be promised to none. They had had experience with Germans before. And a plane promised immunity could see a lot, and report back. The answer was an uncompromising 'No.'

"Then Germany proposed an alternative.

" 'Send your envoys over our lines in a plane of your own,' was the substance of their next proposal.

"Again the Allies answered 'No.'

"Even if the chief should guarantee safe conduct to an Allied plane, individual battery commanders and gunners could not be trusted. The lives of men important enough to be plenipotentiaries were too important to expose thus.

"Then the Allies made a proposal, and the road that the German envoys were to follow in crossing the French lines was laid out. It was the road from Chimay through Fourmies and La Capelle to Guise. And the Germans were instructed to come by automobile and to carry white flags. They were told where the French sentries would challenge them and what they were to do.

"What followed? The conference in the railway car, at which Marshal Foch read to the German delegates the terms that meant—if they did not actually say— 'Unconditional surrender,' everybody knows."

Both Sides of the Government Ownership Question

A Summary of Opposing Testimony Given in the Congressional Hearings on the Alexander Bill

IN the February issue amateur aspects and arguments on the question of government ownership of wireless were given. The present article summarizes the general trend of argument, other than amateur, on the Alexander Bill, as heard before the Merchant Marine Committee of the House of Representatives in Washington from December 12 last, to December 19.

The case for the Navy was opened by Secretary Daniels, with the initial statement: "This is a bill that would give the Navy Department the ownership, the exclusive ownership, of all wireless communication for commercial purposes."

In general substance the remarks of the Secretary of the Navy then attempted justification of the proposal because of the excellence of the radio communication organization which the Navy had builded up during the war, the argument being that only through similar peace-time control by one agency could interference be eliminated. He outlined the "receiving center" scheme on the Atlantic coast, the principal stations being at Belmar, N. J., and Otter Cliffs, Me., these stations being connected by wire with Washington. A control station at the capital also served for the simultaneous operation of the four high-power transmitting stations at Annapolis, Sayville, Tuckerton and New Brunswick.

The plan for recording any violation of regulations which would enable enemy submarines to locate merchant vessels off the Atlantic coast was mentioned, this scheme having provided for daily "logs" kept by 37 "intercepting stations," which were equipped with radio compasses for locating suspicious or enemy stations. The equipment of seaplanes and submarine chasers with radio telephones and listening devices was also reviewed.

The Secretary next told of the purchase of the Marconi and Federal shore stations, excepting the Marconi high-power equipments, which increased the number of naval shore stations from 58 to 111. Commending the Navy for its transactions of commercial wireless business, he then said that it but required the passage of the bill to enable it to continue its control for all time.

Congressmen Green and Edmonds viciously attacked the principle of Government ownership revealed in the proposal for monopoly, immediately after Secretary Daniels ceased speaking. Following this, inquiry was made as to the probable cost of the acquisition, which Mr. Daniels estimated, "somewhere in the neighborhood of $5,000,000," which would not include patents and patent rights, a matter for adjudication in the courts.

A heated controversy arose over the Navy's purchase of commercial ship and shore wireless equipment, Congressman Edmonds stating that "after this committee refused to bring out a bill to purchase wireless apparatus, you utilized the Government's money to purchase this wireless apparatus and took over the commercial systems without the consent of Congress." Mr. Daniels said the action was not in defiance of Congress, but the purchase had been made as a good business proposition with funds available through the naval bill. The discussion then disclosed that the buying proposal so far as it relates to the ship sets, originated with the Shipping Board and that the Marconi Company had at first objected to the sale. Congressman Edmonds stated that the action had embarked the nation on a project which should have had the authority of Congress. "The operation of ships by the Shipping Board is limited to a certain term of years," he said, "whereas you are trying a permanent policy on the Government of having a monopoly of the radio business."

Commander S. C. Hooper, U. S. N., executive officer radio division, Bureau of Steam Engineering, Navy Department, soon afterward received permission from Secretary Daniels to speak about the board appointed to look into the patent situation. First explaining the complications which have arisen over existing radio patents and the arrangement made by the patriotic manufacturers to "call off all patent rights until after the war," he said that several months prior to the ending of hostilities a board had been appointed to settle up the patent situation. Its composition included a representative of the Departments of Navy, War and Justice, with a general policy of trying to see "that everybody gets what is coming to him."

Referring again to the bill itself and questioning Mr. Daniels, Congressman Saunders asked if the present law did not give the Navy everything required for the public protection in time of war. The Secretary replied that this was so. Then, under a hot verbal cross-fire from several members of the committee, Secretary Daniels and Commander Hooper narrowed the argument for ownership down to the problem of interference, which, in their opinion, could only be solved by giving a complete monopoly of radio either to the Government or a single commercial company.

Captain David W. Todd, U. S. N., Director of Naval Communications, opened the first afternoon's session by introducing the amendment to include amateurs in the scope of the bill. This subject was clearly outlined in the February issue and will not be again reviewed here. The Navy's representative then summarized the history of radio regulation by law, and outlined the condition which prevailed up to America's entrance into the war. With this as a basis, his argument was then directed to the economic value of a monopoly in ship-to-shore wireless. For a commercial station to be located and operated alongside a station in Government hands he considered an economic loss, because naval stations must have full crews and be maintained day and night; by permitting them to handle commercial business it looked to him as if the ship-to-shore traffic would gradually drift into the hands of the Government. In the matter of high-power stations, he noted their increase and mentioned how Great Britain had encouraged the English Marconi Company, nearly all privately owned stations in that country being Marconi plants, although there was no monopoly by law. On question from Congressman Saunders, who thought Great Britain's shipping interests gave her more convincing arguments for Government ownership, Captain Todd replied that he expected Great Britain would buy out the English Marconi Company, but added, "I may not have good reasons for believing that."

Congressman Green gave his opinion that if the British Government had such an idea, it was not necessarily a good example for us to follow. Arguing then that monopoly of operation required ownership also, Captain Todd thought the control under the present law too weak, because any foreign Government could secure a license and erect a station anywhere in the United States. Congressman Humphreys said, of course Congress could

amend that feature of the law. The naval communication official then voiced his expectation that, at the next international radio conference the consensus of opinion of the nations represented would be for absolute Government operation of high-power stations, or they would call for such strict control that it would amount to the same thing.

Captain Todd thought Government ownership also necessary for the reason that with hostilities impending at some future time the transfer of control might be looked upon as a hostile or unfriendly move. Congressman Humphreys closed the discussion in this point by the statement that it was hoped the United States "would not come into any war of its own choosing except as a defensive matter," and preparation in such case would rather have the effect of letting a belligerent nation know "perhaps he had better not be so quick to embroil us."

It was next pointed out by members of the committee that one section of the bill was so worded that, should the Government take over the stations, owners could only be compensated in the event that a claim was filed within two years. This wording was defective in the opinion of Captain Todd, and the time-limiting clause was stricken out.

Following an extended discussion on the necessity for keeping naval shore station operators idle when they might be, in time of peace, engaged in handling commercial messages, the director of naval communications noted that the present law did not specifically apply to high-power stations, and that it would be a very great waste for the Government to keep its high-power station quiet; that, in short, permission to handle commercial business with these long-distance equipments was very desirable. Various aspects of the possibility of international complications resulting from such practice were discussed, Congressman Edmonds noting that England and Germany and the United States—three great commercial nations of the world—have not owned their wireless. The question rested with the observation of Congressman White that it made a material difference whether governments had forbidden private enterprise in radio or that private persons had not been encouraged by commercial business to build stations.

Lieutenant Cooper, U. S. N. R. F., the former amateur whose discussion of the experimenters' problems was outlined in the February issue, followed at the conclusion of Captain Todd's testimony. In dealing with the high-power situation, he made the broad statement that, due to war experience, the Navy was in a superior position from a practical operating basis. He explained the distant control system of transmitting, by which four operators in one room in Washington operated the stations at Annapolis, Sayville, Tuckerton and New Brunswick. The Marconi station at Belmar and the naval station at Otter Cliffs, near Bar Harbor, Me., were used for receiving. He then added the opinion that the number of high-power stations now on the Atlantic coast was close to the practical limit, stating that the longest wave length at present in use is about 17,000 meters and that he doubted whether any practical working wave lengths were left. In explanation of this statement he noted that Tuckerton used about 8,900 meters and Nantes, in France, used 9,000 meters on some of its schedules, causing interference. The regular wave for trans-Atlantic traffic he gave as 10,000 meters.

On question from Congressman Edmonds, the naval reservist thought 500 to 750 meters difference was required between very sharply tuned high-power stations to prevent interference. He was not prepared to definitely state, however, he admitted, whether with increasing demand for high-power equipments the maximum wave length would not be extended beyond the present 17,000 meters, making more wave lengths available. His concluding statement to the effect that the Navy was ahead of commercial companies in installing the newest long-distance apparatus, met with the rejoinder from Congressman Edmonds that the Navy did not have to exercise any care as to how much money it spends or pays for patents as private companies do.

Commander Hooper appeared next as the Navy's technical officer, paying the fine initial tribute to the commercial and scientific radio men in civilian life which was quoted in full in the February issue. Speaking on the question of interference, he thought that average gradations of 300 meters between stations, practically speaking, would prevent interference; with low-power stations, tuning within 25, or even 15, meters was practicable. In the matter of coastal stations the substance of his argument was that waste was encountered by having two systems and that through Government ownership safety at sea would be best insured. For high-power stations, he argued, Government ownership presented many advantages and on the interference problem, trouble was being stored up if no Congressional action was to be taken. Otherwise, he looked forward to complaints of alleged disrespect to foreign nations becoming a matter to be taken up through diplomatic channels. Commander Hooper thought that with a multiplicity of high-power stations built in different countries an international commission might decide that only one station could be used in a country and commercial interests might lose on their investment of millions. Congressman Edmonds said that this was a matter of commercial risk, and it was no business of Congress to regulate a man's commercial desires.

The technical officer read a review of naval radio activities during the war, dated October 24, 1918. It showed that during the fiscal year, 1,282 new installations for naval vessels had been provided for. Contracts had been made for wireless equipment for about 2,500 new vessels of the Shipping Board. The total number of existing and prospective installations provided for and maintained was in excess of 4,000. Coastal stations maintained and operated totaled 125, of which 75 were commercial plants taken over by the Government. In aircraft radio, 50 service and 40 training 'planes had been equipped, and 60 outfits shipped abroad. Contracts had been awarded for approximately 3,000 complete airplane sets. A large proportion of the report was commendatory of the technical advances made.

At the conclusion of the reading Congressman Edmonds developed the fact that advances in the art had not been made by employees of the Navy Department. The radio telephone was instanced, and Commander Hooper offset the newspaper credit given to the Government for this invention, stating that commercial companies deserved the credit.

Hon. Breckinridge Long, Third Asst. Secretary of State, next appeared as a proponent, saying that the State Department desired to express its entire approval of the substance of the bill. The primary reason, he said, was the international one and its specific application to communications during war. The Chairman inquiring whether there had been any lack of power under the existing law, Mr. Long replied that he was speaking only from the point of view of policy. Mr. Long admitted later that by Congressional act, regulation could be established which would meet the situation.

Commander Hooper, in a supplementary statement, dealt with the patent situation, pointing out its complexity. He explained that manufacturers of wireless apparatus had been required to protect the Government from all infringement claims, a clause which was stricken out of contracts during the war. To attempt settlement of various patents rights, he said, the board which Secretary Daniels had earlier referred to had been created, which would try to decide the merits of claims represented in purchases of apparatus amounting to $30,000,000 or $50,000,000. The decision, when agreement was reached, would then be referred to the Court of Claims. This ar-

rangement being termed irrelevant to the bill's provisions, the navy's technical representative was questioned at length on the lack of reward to the inventor under Government monopoly. He said that he believed inventors "would rather take a chance with the Government," to which Congressman Edmonds returned: "I have not seen any of them rushing around here yet to support the bill."

From the viewpoint of interference at present, Commander Hooper admitted that it was not essential to take the high-power stations, but thought it bad policy to permit commercial companies to build a lot of expensive stations which they might find could not be used because of interference.

C. B. Cooper, New York manager for Kilbourne & Clarke, supported the bill in the interests of his own company and three Pacific coast shipping concerns. The substance of his plea for the bill's passage was the opinion that Government ownership provided the most efficient means of handling the ship-to-shore radio service.

The attack by the opponents of the bill was opened by Edward J. Nally, vice-president and general manager, Marconi Wireless Telegraph Company of America, and president, Pan-American Wireless Telegraph and Telephone Company.

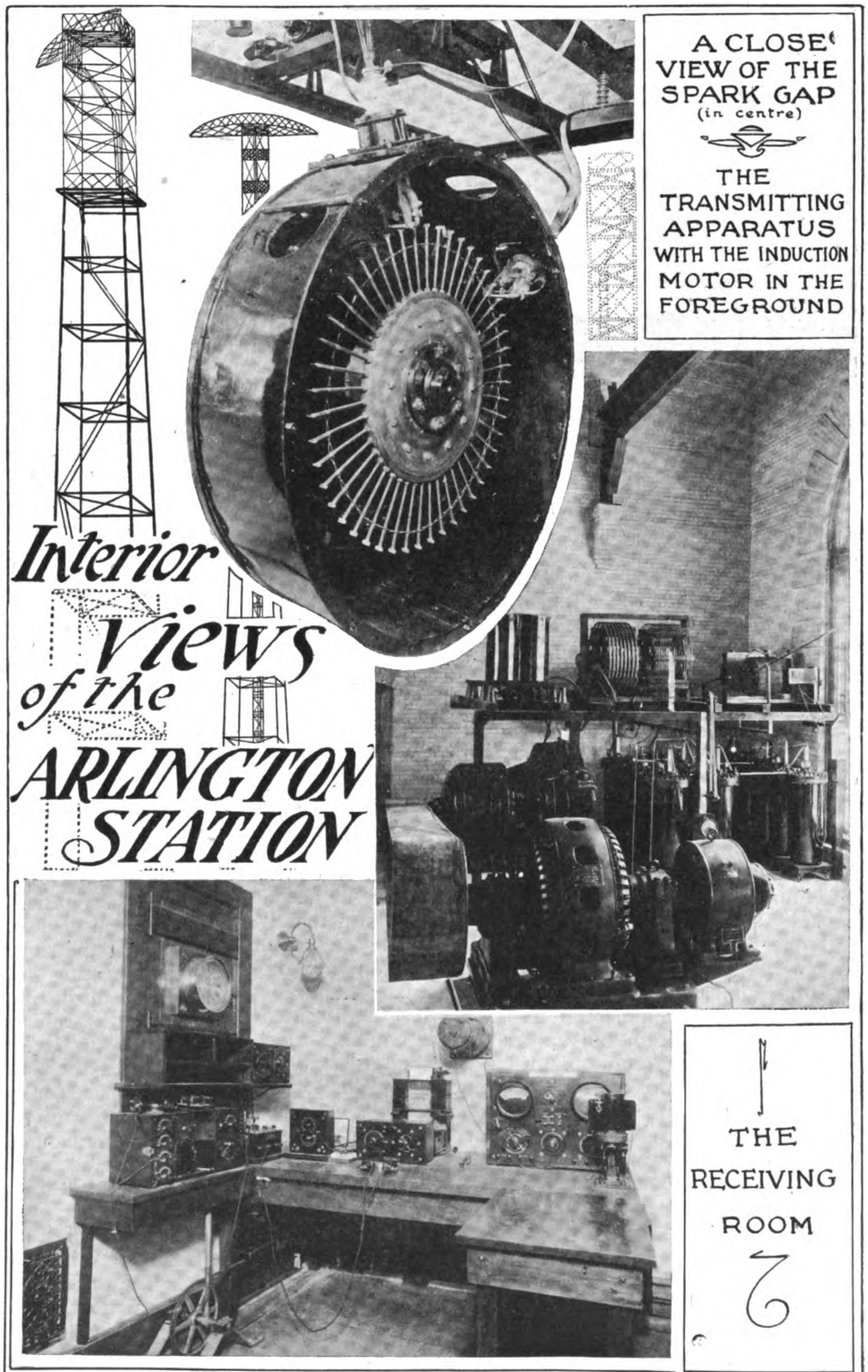
After establishing, on question from the Chairman, that the Pan-American Company was organized a year ago to operate in South America and represented majority American holdings, Mr. Nally called attention to the press statement of Congressman Alexander, which incorporated the Navy Department's reasons for Government ownership. He took exception to the statements that "radiotelegraphy is not a serious competitor of the cables," and "high-power stations are not yet able to receive from one another all day in all seasons," referring to the evidence of the Navy officials before the committee which was strongly to the contrary, especially Commander Hooper's statement on the reliability of communication across the ocean, literally, "now we never miss a message from the other side; that is a fact."

On the question of secrecy Mr. Nally said: "It had always been acknowledged that cable communication possesses the virtue of secrecy, but I was startled some months ago by a report coming from a representative of the Navy Department that there were reasons for the belief that submarine cable communication would be no longer secret, and it was feared that the enemy was copying all of the intelligence which passed between the United States and our allies.

"This was supposed to have been accomplished by laying a short length of submarine cable parallel to and alongside of the existing cable, and continuing the short length into Germany, where signals induced in the short length of cable were easily read by means of recorders and magnifiers.

"This is an old trick, often played on land, but the report was not credited by practical cable engineers; nevertheless, it was an interesting possibility and inasmuch as it was sponsored by representatives of the Navy Department there is no reason why they should not be expected to support the statement in contradiction of their present statement that submarine cable communication is secret.

"It is quite true that 'signals from radio stations are transmitted equally in all directions,' but it is not true



Interior Views of the Arlington Station

A CLOSE VIEW OF THE SPARK GAP (in centre)

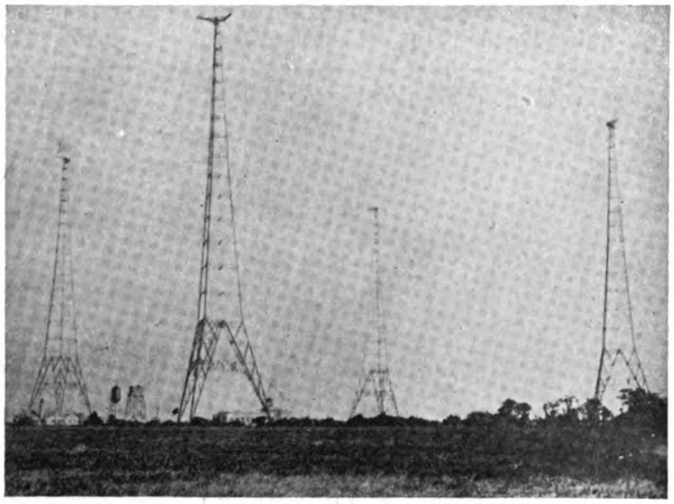
THE TRANSMITTING APPARATUS WITH THE INDUCTION MOTOR IN THE FOREGROUND

THE RECEIVING ROOM

that 'all nations can read the business of all others.' That one individual may not learn the business of another and that one nation may not know the private correspondence of another is the prime reason for the use of codes and ciphers."

He thought it misleading to say that wireless telegraphy is not a serious competitor of the cables, noting that both have distinct and separate value, and that some of the reasons urged against radio would not bear analysis.

He then anticipated the possibility a world-wide range station broadcasting a daily digest of American news in the interests of international harmony, a service impossible of duplication by submarine cables.



The 650-foot towers of the new Annapolis station, the naval high-power installation which was prominently featured in the discussion of the bill

Lieutenant Cooper's testimony was the next subject for his examination. The attempt made by the ex-amateur to imply that sensational progress in the art had been made during the eighteen months of war was misleading, he showed, by analysis of the three most important advances Lieutenant Cooper had related. These were (1) distant control; (2) success in duplex operation; (3) the design of a directional antenna.

Commenting on the first so-called advance in the art, Mr. Nally said:

"In order that the committee might appreciate the correct facts in the development of distant control and duplex operation, and of which apparently some naval officers are not even aware, it is only necessary to mention that transoceanic communication was first established by the Marconi Company between Ireland and Nova Scotia, in 1907, or 11 years ago. The service rendered at that time was limited in character and was utilized mainly by newspapers. The service, however, was so successful that it was opened the following year, 1908, or 10 years ago, to general public correspondence in competition with the existing submarine cable facilities, and many hundreds of thousands of commercial messages were transmitted between Great Britain and Canada, or the United States, without serious interruption, until 1917, when the stations were utilized exclusively for governmental purposes. In passing, I might mention that this same trans-Atlantic service has been released by the British and Canadian naval authorities since the armistice was signed, and is again open to commercial intercourse in competition with the submarine cables.

"This was the first and most important long-distance wireless commercial circuit, and the experience gained in the operation of this pioneer circuit has been of inestimable value to the art in the development and progress of later and higher powered transoceanic wireless circuits. During all this time, when the obstacles appeared almost unsurmountable and when the financial success of such service was seriously doubted by most people, there was no particular interest in international radio communication shown by our Navy Department. It is true that the Navy Department, within the last five years, has built a number of high-power stations, the object of which was to communicate in emergency with our naval outposts, such as Hawaii, Guam, and the Panama Canal; but the first noticeable desire of the Navy Department to engage in commercial international communication, was discernible shortly after circumstances, with which the committee is thoroughly familiar, placed the operation of the Sayville and Tuckerton high-power stations in the hands of the Navy Department. They immediately realized the full possibilities of an international high-power radio circuit, and we have it on record, in the minutes of the previous hearing, that the operation of these stations was so profitable that within a period of two years, and after deducting all naval operating charges, a return of over 30 per cent has been earned upon the investment. This high return, however, was not so much due to the efficient operation of the stations, as claimed by the Navy Department, as to the exorbitant tolls which were charged on the traffic handled. Prior to the severance of the submarine cables connecting the United States with Germany, the tariffs were 25 cents and 12½ cents per word, but during the time that the radio stations were operated by the Navy Department, this tariff was set at 50 cents per word.

"As Secretary Daniels openly informed us, a few days ago, it would be 'good business' for the Navy Department to take over the operation of all high-power radio stations, but it should not be forgotten that this 'good business' was foreseen in 1908 by the Marconi Company and ever since that time we have been striving to improve our high-power machinery, so that we might have an opportunity to fully enjoy the fruits of our labors, and also to earn for our 22,000 stockholders some suitable return on the investment of the many millions which we have placed into high-power stations waiting at this moment to furnish a commercial international high-power service to Great Britain and Ireland, to Scandinavia and Russia, and to Hawaii, Japan, and the Far East."

Claims had been made by the Navy for the specific improvements represented by distant control and duplex operation; on this question Mr. Nally observed: "Radio engineers the world over will corroborate my statement that the Marconi Company was the originator of the schemes of duplex operation and distant control. In the year 1912, the original trans-Atlantic service having become congested with traffic, it became necessary to increase its carrying capacity, and Marconi engineers planned the method by which the capacity of that circuit was doubled by the use of duplex operation; and, since that date—I repeat, this was six years ago—the trans-Atlantic service spoken of, has been continuously worked duplex. At the same date, Marconi engineers arranged for the operating key to be placed some 50 miles away from the transmitting machinery, and this has since that time been the sole manner in which all Marconi high-power stations have been operated. This, gentlemen, is the same distant control of which you have heard Lieutenant Cooper speak in connection with his concentrated telegraph office in the Navy Department Building.

"The American Marconi high-power stations, which were completed on the Atlantic coast in 1914," he continued, "were designated for exclusive duplex operation and are so arranged today. The American Marconi trans-Pacific high-power stations, which have seen commercial operation since September 24, 1914, were designed for duplex operation and were operated by this same system of duplex control. For confirmation of this fact Lieutenant Cooper need only ask several of his ex-Marconi operators now working for him in the Navy

Department Building, and who formerly operated in a highly efficient manner the Marconi trans-Pacific high-power service to Hawaii and Japan.

"We are particularly gratified to learn of the Navy Department's success with the egg-shaped wave," the speaker next observed, "and it will surely interest Mr. Marconi, who invented and patented the well-known Marconi directional aerial many years ago, the effect of which is to project a wave more effective in the direction of the receiving station than in any other direction. All Marconi high-power stations in this country were equipped with this 'egg-shaped wave' producing antenna in 1913 and 1914."

Mr. Nally recalled to the committee's attention the statement of Lieutenant Cooper that the Navy Department was best able, from a practical operating basis, to say what could be done, because the Navy, during the war, had more experience in handling high-power radio traffic. "The radio traffic expert," Mr. Nally observed, "who was singled out by the Navy to directly supervise the operators employed in this central radio station in Washington, where such alleged wonders have been worked, was, up to the date of our entering the war, in direct charge of the Marconi high-power trans-Pacific circuit. He has devoted his career to the problems of radio communication and patriotically offered his services to the Navy Department when they were in need of highly qualified men. We do not claim to have a monopoly on operating talent, but the fact stands out strongly that the Navy Department, in April, 1917, when this country entered the war, was short of really competent, high-grade transoceanic operators and appealed to this company for such men as we had specially selected and specially trained for this important branch of radio.

"It should be realized that there is a vast difference in the efficient operation of a ship-to-shore service and the requirements of a high-powered international service. This latter work is most exacting, and perhaps not more than a few out of a possible hundred average wireless operators have the requisite ability to satisfactorily cope with the heavy and high-speed work encountered on a transoceanic wireless circuit. I have already said that this company had picked a group of specialists, and it was these men the Navy Department made special call for, to assist in the new high-power responsibilities when this country entered the war. With one or two exceptions, the whole of this force volunteered its services to the Navy Department, and they are today to be found occupying responsible positions both in the high-power stations being operated by the Navy Department and also in the central radio office, with which Lieutenant Cooper himself is connected.

"I might also say," he continued, "that the Marconi Company has successfully operated transoceanic radio service at a higher rate of speed than has ever been accomplished by other agencies. The Marconi Company was the pioneer in automatic high-speed transmission and automatic high-speed reception. It has developed this system to a remarkable degree of proficiency. Whereas it is not possible to operate a radio circuit by hand (or, as we term it, manual operation) at more than 30 words per minute, the Marconi Company has successfully and for long periods transmitted by automatic-speed operation at speeds varying from 60 to 100 words per minute. This remarkable advance in the art, as can readily be seen, immediately doubles and even quadruples the capacity of a single circuit. I believe I am safe in saying that the Navy Department still makes use of the old system of manual transmission in the operation of its high-power stations."

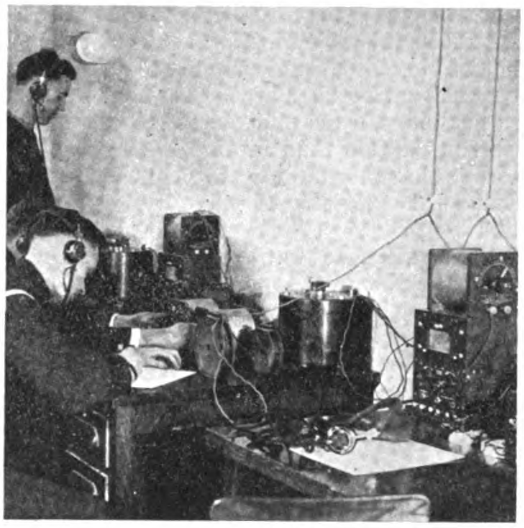
To illustrate that no essential difference in principle existed between radio and wire communication—quoting a statement made by the Postmaster General Burleson—Mr. Nally referred to his personal career of pioneering in all forms of electrical communication, a continuous experience since 1875, and said that he felt no appreciable change when, in 1913, he transferred his activities to wireless. He then touched upon the unfortunate early history of the art in the hands of unscrupulous promoters. The change in conditions he made clear, then, by the observations: "The year 1912 found the Marconi Wireless Telegraph Company of America in full possession of all property formerly belonging to the defunct and dishonest United Wireless Telegraph Company, and the Marconi Company undertook to construct a substantial and highly efficient organization to serve the public, and I can truthfully say that it has succeeding in doing so. The corporation today is as clean as a hound's tooth, it is vigorous and virile, and it has made surprising strides in the last few years and in the face of a most difficult and, at times, most discouraging condition and under circumstances that would ordinarily have caused failure to a less vigorous organization."

Acknowledging the tribute which had been made by Commander Hooper to the Marconi Company and its general manager, Mr. Nally briefly summarized the pre-war and war activities which had earned this credit. He explained how the chain of high-power stations had been built and a highly skilled operating personnel selected and trained for the various transoceanic services, which the Government took over with our entrance into the war. He also noted that the largest source of supply from which trained wireless operators were drawn was represented in the many thousand graduates of the Marconi schools of instruction. The subsidiary company's magazines and textbooks, he noted also, could be found in the homes of nearly every wireless student in the country. Expansion of the Aldene factory to meet Government demands was dwelt upon, more than 3,000 wireless sets being there designed and developed for use in the war.

The object and program of the Pan-American Company was explained in detail from its inception by letters written to the Navy Department and Secretary Daniels by Mr. Nally as the company's president. This correspondence developed the fact that the only opposition to Americans owning and operating wireless stations in South America came from our Government; none from the South American governments; in fact, all of the government officials on the southern continent were enthusiastic and anxious to assist in every way. Secretary Daniels, it was said, was absolutely committed to Government ownership, but the Navy Department hoped the Pan-American Company would go ahead with construction of its Argentina station without any assurance of being allowed to erect the United States communicating station.

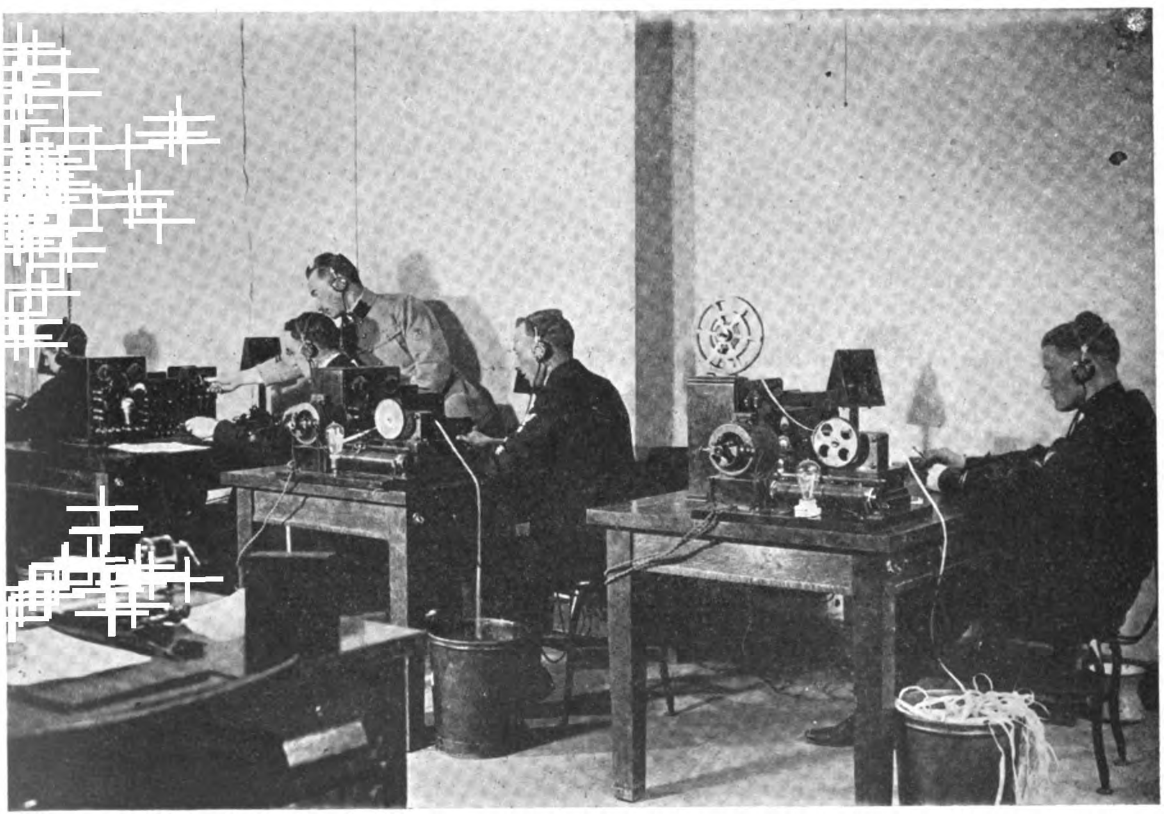
By contrast with commercial wireless agencies of other countries, many handicaps were suffered by United States manufacturers and operators, a fact which was illustrated by a referenee to conditions encountered in Mexico. In this country, Mr. Nally said, the Germans were in full control of the wireless stations. The new Mexican constitution of 1916 provided for Government ownership and, lacking capital for extension of service, the Carranza government fell an easy victim to the wiles of the German Telefunken Company. "There exists no particular prejudice in the matter of doing business with American private corporations," Mr. Nally remarked, "and if our company had been in position to go ahead freely and with the support and cooperation that our business men have a right to expect from the United States Government in their dealings abroad, it might have happened that, instead of there being upward of 25 wireless stations in Mexico under German control, as at present, there would be 25 under American control. And if an American private company were in control in Mexico I am sure that neither Secretary Daniels nor this committee, nor the people of the United States in general, would fail to see anything but a decided military advantage in times

Iultiplex Radio Sending



Above: The receiving room of the central control station in Washington which handled all transoceanic naval messages during the war

To the left: Secretary of the Navy Daniels, whose campaign for government ownership was largely based upon the contention that interference could only be removed by centralizing control of high-power station operation



hotos by Int'l.

A general view of the perforating machines for messages transmitted from the centralized station by distant control

of war and an equally valuable commercial advantage in times of peace.

"Although the Mexican Government claims title to all these stations," he explained, "the apparatus is strictly German and there have been German operators in every one of the 25 odd stations. Moreover, there have sprung up Government electrical shops with German superintendents, and the whole system has been supervised by German radio experts who were formerly employed at Sayville and Tuckerton and on the German liners which were interned in this country at the beginning of the war."

Answering the federal ownership advocates who had stressed economic loss and retention of obsolete equipment under private ownership, the Marconi executive maintained that large undertakings were retarded because of the Government's wet blanket of ownership causing uncertainty, and gave instances where high-power apparatus had been scrapped and replaced, to prove that private enterprise made this a practice in the interests of increased revenue.

In closing, Mr. Nally submitted a concrete plan designed to bring to an end costly controversy between the Government and private companies. This scheme gave (a) the Government exclusive right for ship-to-shore commercial wireless, (b) private companies to receive governmental sanction to develop and extend commercial transoceanic and overland wireless, without commercial competition from the Government, and (c) amateur regulation satisfactory to both federal officials and the experimenters. He suggested that the Secretary of Commerce continue the licensing function and a national radio commission representing in its membership of five, federal and private interests, to apportion wave lengths, hear appeals where licenses may be refused or revoked, and recommend to Congress whatever additional legislation may be necessary from time to time. In the interests of national safety he offered, in behalf of the Marconi Company, that only American citizens be employed to operate high-power stations and all to be enrolled in a reserve subject to military call.

Following a considerable period of cross-questioning by the committee dealing mainly with the principle of Government ownership, Mr. Nally was succeeded by David Sarnoff, commercial manager of the Marconi Company and vice-president of the Pan-American Company. Mr. Sarnoff explained in detail the circumstances which led up to the sale of the Marconi coastal stations and ship sets to the Navy Department, showing that as soon as the Navy obtained complete control of all wireless stations and operations at the outbreak of the war "it followed a line of action which appeared to us calculated to destroy the Marconi rental system and to render the Marconi coastal stations worthless at the end of the war," so there would be no alternative but to sell the coastal stations to the Government.

He then attacked the bill as a measure that would stifle the development of the radio art. He quoted the utterance of Hon. Thomas Ewing, U. S. Commissioner of Patents, who, in 1917, said that if the Government took over wireless it would largely be the end of its development and that, in the "matter of encouraging scientific invention the Government is not a shining success in comparison with private enterprise." Mr. Sarnoff drew attention to the fact that actual operating experience had in most cases been the basis upon which invention and improvement rested, questioning then where the outside technical experts could obtain further experience and knowledge of operating conditions under a naval monopoly of operation. Government salaries, too, were noted to be unattractive to commercial experts and offered no inducement to them to become a Government employe.

Restriction of overland communication was another of the bill's evils, Mr. Sarnoff contended; he illustrated its utility on railroads, showing that in one paralyzing storm the wireless equipment of the Lackawana saved the company $150,000.

"And what shall we say about the future of the wireless telephone, which is rapidly coming to the front," he added, "and to which the world war has given great impetus? Leave the commercial expansion of the radio art unhampered and I am confident that it is only a matter of a few years when we shall have transcontinental radiotelephony. That this is scientifically possible has already been demonstrated; it but remains for technical experts to perfect existing wireless telephone apparatus, and for private enterprise to erect high-power radio telephone stations to effectively compete with telephone lines and materially reduce telephone tolls. It could not help but reduce the rates, because a radio telephone station located in New York and another in San Francisco, capable of continuous transcontinental communication, will be possible of erection at an investment of approximately $1,000,000, and this investment is small, indeed, compared with the investment which the users tie up when talking over a long-distance wire telephone circuit strung between New York and San Francisco, which investment, I should say, roughly, represents $20,000,000."

His next subject was the interference problem, which he termed the keynote of the proponents' arguments, as expressed by Secretary Daniels as the "sole reason" for the proposed monopoly.

"The fact that Navy Department admits that there is no way in which to solve the interference problem except by legislation bears the most eloquent testimony to its poverty in scientific perception and its lack of faith in human genius to overcome this problem," he said. "In my judgment and in the judgment of men whose scientific opinions are infinitely more valuable than mine, the problem of static interference—which interference Prof. Pupin so aptly termed an 'act of God'—was a far more serious and more puzzling and less hopeful problem to solve than that of wave-length interference—'the act of man.'

"In discussing the static problem with radio men I have in the years gone by been told by some of the leading scientific experts that in their opinion the static problem was unsolvable and that there was no way to overcome it, and yet this baffling problem, an obstacle to continuous radio communication over long distances, has been solved, and solved by an American in civilian life, who has never been connected with the Navy Department or any other Government agency.

"Only yesterday I discussed anew with the inventor of the static preventer the question of interference and asked his opinion in the matter. He unhesitatingly replied that he felt confident of the complete solution of the interference problem, and, what is more, he stated that right now, every day, definite and important progress is being made and that the complete solution of what is left of the interference problem is almost in sight.

"If the members of this committee can find an opportunity to refer to the records of the last hearing, held in this room on a similar bill, when the matter of interference was discussed, they will find that what I have said and quoted is confirmed by the opinions expressed by such scientific geniuses and men skilled in the radio art as Prof. Pupin, of Columbia University; Prof. Kennelly, of Harvard University, and Prof. Goldsmith, of the College of the City of New York.

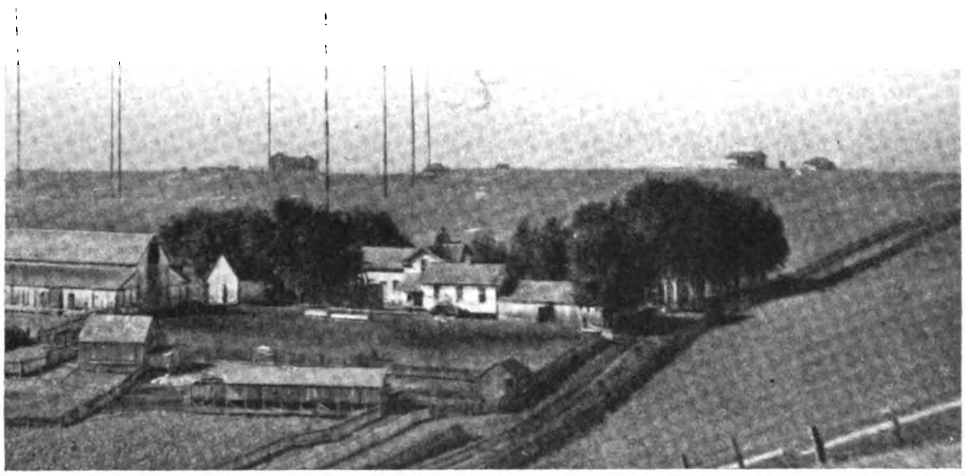
"As against the opinions of leading scientific minds, let me ask which of the proponents of this bill who have thus far appeared before your committee are willing to take issue with these men and their opinions, and to state as a scientific conclusion that the interference problem is unsolvable? And, further, that there is no other way to meet the emergency except by legislating interference out of existence, which, perforce, means limiting the number of stations operating at the same time and conse-

quently limiting the number of messages which can be sent and received at the same time. This would place an artificial barrier on the expansion and development of a public utility, which bids fair, under commercial operation, not only to rival but to surpass every other means of intelligence transmission. If such there be among the proponents of this bill, let me say for his information that "interference" has not singled out radio communication for its sole attack. Mr. Interference has simply come to life again, and is at present in the air but looking down upon the Navy Department, which seems to include the only people fearing his power and who have complained to Congress, seeking his destruction and annihilation through this present bill.

"Our old friend 'interference' seems to have a particular dislike for those who wish to communicate," he added, "and a study of this scientific subject will illustrate that in the early days of land wire telegraphy and telephony they experienced exactly the same trouble from inductive disturbances on the telegraph lines, and cross-talk on the telephone lines. These disturbances were produced in a wire by the operation of neighboring wires. Now, if at that time legislation similar to that now being sought by the Navy Department had been enacted, prohibiting the stringing of telegraph and telephone wires on the same poles and compelling duplicate sets of poles and lines, separated miles apart, would the present high state of perfection of the telegraph and telephone systems have been reached? I think not.

"What happened instead? The scientific minds struggled with the problem until they solved it, and interference from neighboring wires is no longer a problem, and as many wires can be strung on a pole line as the poles will hold, and they can be placed almost as near together as you please. This, of course, means a tremendous saving in the expense of installation and operation of telegraph and telephone lines.

"The honorable Secretary has stated that 'there is a certain amount of ether, and you can not divide it up among the people as they choose to use it; one hand must control it.'. Now, the ether knows no national boundaries, or 3-mile limits; it is a common and international medium, and therefore it is not possible for one hand to control it. It is not the American people, and not the American stations which our Government will have difficulty in controlling, because it has the power of the present regulations, and the ability to obtain more regulation if this, in the judgment of Congress, seems necessary. It is the foreign stations that may cause the greatest amount of interference, and we have no means of controlling them except by international agreement, and if we can get along harmoniously with all of our neighbors in the rest of the world by living up to international agreements, why is it impossible or impracticable for the Navy Department to get along amicably, and to work harmoniously with its friends on American soil? One hand —to use the Secretary's phrase—may control all the high-power stations in the United States, but that will not prevent interference from such stations as may be erected in Canada, or in Cuba, or in Mexico, or in any South American country.



One view of the California end of the Marconi trans-Pacific circuit, for the operation of which it was stated few operators could qualify

"Gentlemen," he continued, "it must be evident to you that this question of interference, which, it has been stated, is the sole reason for this bill, is really not a reason—it is an excuse for obtaining Government ownership and Government monopoly of all radio communication in this country. Our friends the English, who have had experience in telephone lines, do not seem to fear the increas-

ing number of high-power stations, and are making extensive arrangements for some long-distance stations, and it is significant, too, that the British Government, while operating telegraph and telephone lines, has not, so far as we know, launched on a policy of Government ownership of high-power radio stations.

"It has been stated to you that only seven countries at present favor or permit private ownership of radio sta-

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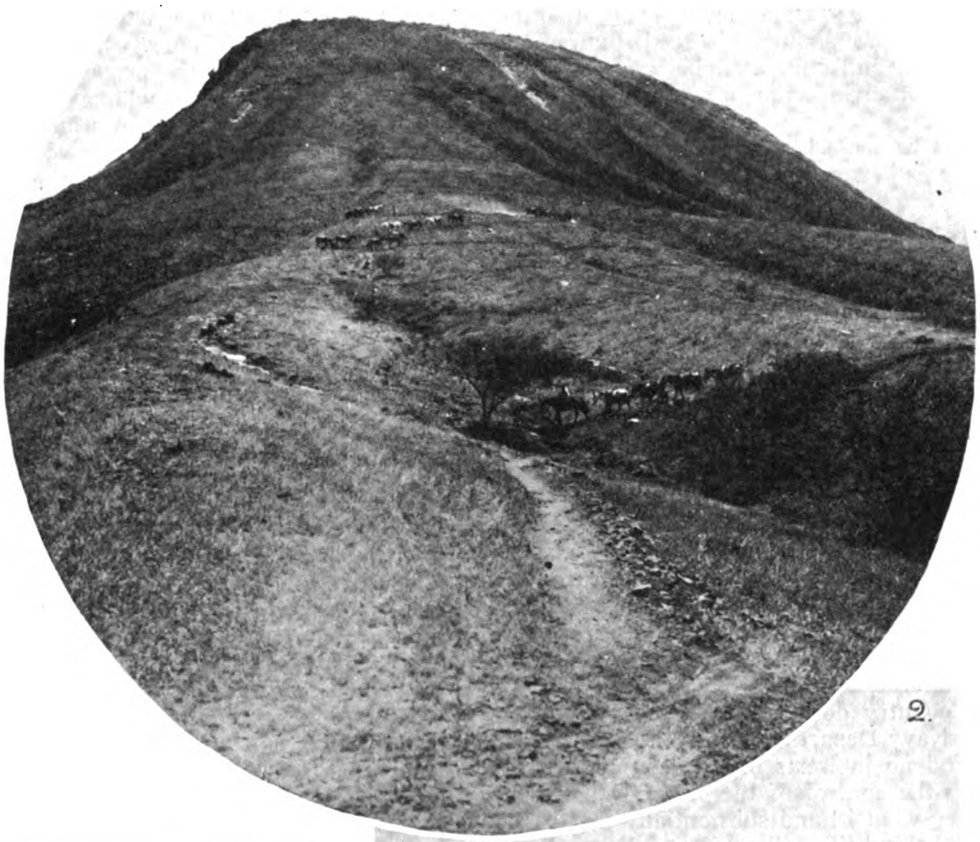

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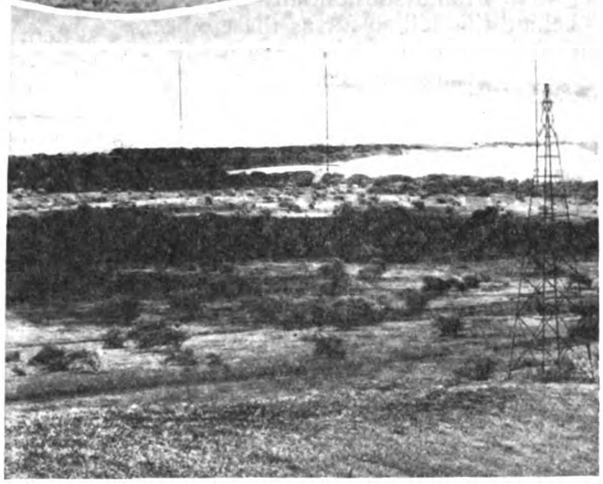

1. An extinct crater in Hawaii which serves as the site for mast erection of one of the Marconi stations, illustrating the type of engineering problem encountered in establishing a world-wide wireless system

2. The utility of wireless in Hawaii was emphasized by a representative of the mid-Pacific business men who protested against the Navy's bureaucratic administration; the photo shows the mast line of Marconi's receiving station

tions, but it has not been stated that these seven countries are the only countries which have helped to develop wireless communication, and, therefore, the proponents of this bill have not claimed that ship-to-shore radio communication would be interfered with by the working of high-power radio stations, and I merely wish to emphasize this important fact that private operation of commercial high-power international radio stations has nothing whatever to do with the interference problem—so far as this problem applies to ship and shore work."

In summary of his remarks on interference, Mr. Sarnoff gave his opinion that the enforcement of intelligent regulation would provide all of the benefits sought with none of the perils to the art the bill imposed.

Hon. John W. Griggs, president of the American Marconi Company, was heard next. He observed that the bill seemed to bear most directly and hardest on his company, the most important in capital, property and stockholders, and the oldest company in the United States. "Its present capital," he said, "is $10,000,000, and I think its total assets, as figured on its statement, amounts to something like $12,000,000. It has no bonded indebtedness—it has no indebtedness whatever except the week-to-week current bills that it incurs. It has paid two dividends in the course of the 15 or 16 years it has been engaged in business. It has 22,000 stockholders, the most of whom are residents of the United States, who acquired their stock with the hope and expectation that eventually

the Marconi Company would be able to become a successful competitor of the oceanic cables, and thereby would derive a large income which would justify an investor in waiting 10 or 15, or even 20 years, for a dividend, because he expected when the result was obtained he would reap largely in returns."

The scope of the tansoceanic scheme was explained and the expenditure of $5,000,000 in building stations for the international business. He referred to the taking over of these stations at the outbreak of the war, and now that hostilities had ceased, "in comes the military arm of the Government, the Navy Department of the United States, and asks power of Congress to take away from the Marconi Company not only these stations but all of this prospective business that it has been planning and working and spending money for 20 years to develop and build up. Just when the farmer has planted his seed, plowed his field, and harrowed it, and cultivated his crop, and the corn is ready to husk, the Government comes in and says, 'We want that crop.'

"Well, there must be some justification for such action as this. It is unusual; it is severe. The requisitioning of the property devoted to the uses of commerce or manufacture by citizens of America, the requisitioning of that property is harsh, unusual in time of peace, and ought not to be permitted by Congress except on grounds of public necessity. You cannot take ground for a railroad under the laws of condemnation of any State in the Union, unless it is necessary. You cannot take the right to string telegraph or telephone poles unless it is necessary for the purposes I have named."

Governor Griggs then showed the inconsistency of the Navy's reasons for the supposed necessity. He referred to the fact that arguments in 1917 had been military necessity, reasoning which experience had proved fallacious; the present reason was, therefore, a new one—interference. He did not deal with that technical feature, but he referred to the broad question of interfering with the operation by the Navy of its stations when the nation was not at war. "In time of peace the interests of commerce and business are superior to all the navies of the earth," he noted. "This country does not exist for the benefit of the Navy. The Navy Department exists for the benefit of this country, and no interests of this country should be subordinated to the control of the Navy Department merely because they want it, and substantially that is the only reason that is behind this bill so far as these officers of the radio bureau of the department are concerned.

"Let me ask you this: What law compels the Navy Department to transmit official business or press messages by these stations if they take them over? And if they are willing to transmit messages, if they find that the needs of communication in time of peace, when battleships will lie rusting in harbors—if they find that the needs of their service will still permit some business to be carried on, how will they carry it on? We have had a censorship for the last year and a half. No man could send a message by cable unless it passed a Government censor. No newspaper could get a communication from the front unless it was such as the censor permitted to come over the wires. Do you want to perpetuate a censorship in the Navy Department? If, then, the power, the only power, to operate transoceanic stations is the Navy Department, what newspaper, what correspondent, what business house but what would be at the mercy of some lieutenant commander who had a prejudice against the paper or the correspondent or the business house and did not like it, and who would not take their messages unless they conformed to his ideas of what was proper news to send across? Is there anything to hinder that? The interests of the Navy Department could always be cited as the reason why particular news should not come. I do not hesitate to say that I can conceive of no emergency in time of peace connected with the maintenance and operation of the American Navy or naval stations which would require that they should have first control of long-distance wireless. I say the first use belongs to business and commerce; it belongs to the business people, belongs to the press people, to the commercial people of the United States, and it does not belong to the officers of the Navy Department."

Tying up the proposition for radio monopoly to the policy of Government ownership projected by Postmaster General Burleson, the Marconi Company's president called the bill inadequate and inartistic. He strongly attacked its provisions for compensating station owners after confiscation of their property. The methods of dealing with the person whose property is thus taken he termed unjust, unfair and arbitrary. "I want to call your attention," he said, "to the fact that that does not provide at all for just compensation. Just compensation is what the Government owes for the property taken.

"If you have a company like the Marconi Company, that has been 20 years elaborating, improving, expanding, building up to a certain point of perfection, and then the Government comes in and takes that merely at its scrap-rate value, or its value as it stands, and does not take it as its value as a going company, nor take into account what it is capable of earning, nor take into account the money that has been spent working it up, scrapping of machinery and apparatus, and has taken all these 20 years—you see how much encouragement you are giving people to invest their money in enterprises of this kind, and you see how unjust it is to these stockholders, who have been willing to wait, 5, 10 or 15 years until the company could do this business and earn dividends, to buy them out for the scrap value of their stations.

"Two years ago Captain Todd said significantly that he thought these stations could be got for $5,000,000 and if we waited five years they would be worth $20,000,000," he continued. "There was evidence that Captain Todd knew when these stations were put in operation the large business that we expect was coming to them and the profits that were earned by the company, property which represented merely on the ground $5,000,000, as a going concern would be worth $20,000,000. I do not tie myself to any figures, but you know the difference between the preparation to do business and the doing of business.

"Let us see what it is that they propose thus to take in this arbitrary way. They propose to take the Marconi system in the United States. Well, what is the Marconi system and who is Marconi? I would like to read to you a judicial statement made in 1905 by Judge Townsend, of the United States Circuit Court for the Southern Division of New York, in a patent suit. I read from One Hundred and Thirty-eighth Federal Reporter, page 673:

> The exact contribution of Marconi to the art of spark telegraphy may be stated as follows: Maxwell and Crookes promulgated the theory of electrical oscillations by means of disrupted discharge. Hertz produced these oscillations and described their characteristics. Lodge and Popoff devised apparatus limited to lecture or local experiments or to such impracticable purposes as observation of thunderstorms. Marconi discovered the possibility of making these disclosures available by transforming these oscillations into definite signals, and, availing himself of the means then attained, combined the abandoned and laboratory apparatus and by successive experiments, recognized and developed them into a complete system, capable of commercially utilizing his discoveries.

"Marconi has been recognized by almost all the great scientific societies of the world as the real inventor and discoverer of the practical art. He has had conferred upon him the Nobel prize. The Governments of Great Britain, of France, of Spain, of Belgium, of Russia, of Italy have honored him by reason of that invention. The only two great commercial countries that have persistently refused, so far as their governments are concerned, to recognize Marconi or his patents are the United States and Germany!"

The attitude of the Navy Department toward inventors and patentees was then illuminated by Governor Griggs, telling of the experience of the Marconi Company. "Its patents are supposed to be monopolies," he observed, "and they are given monopolies as incentives to reward invention and discovery; and in that respect we are proud of our monopoly.

"Very early—as early as 1904—the Navy Department began equipping naval vessels with piratical apparatus purchased from companies that made apparatus and sold it embodying the Marconi patents. The Marconi Company protested to the Navy Department against that practice and said it was not fair to a patentee to have the United States Government, which granted the patent, accept goods and buy them from a pirate. It was replied by the admiral, who at that time had charge of the bureau, that the Navy Department took no cognizance of patent rights, except so far as they had been adjudicated by some court. Whereupon the Marconi Company brought a suit against the deForest Wireless Co., and the Marconi patents were sustained as valid, and the deForest Co. was enjoined, and there was a complete judicial determination of the validity of the Marconi patents by Judge Townsend, who was a very able judge.

"Whereupon we meandered again down to the Navy Department and saw the admiral and said to him: 'Sir, we have brought suit against an infringer, and the Circuit Court of the Southern District of New York has declared our patent valid, and we now ask you to cease buying apparatus from these infringers.' And the admiral said: 'We can not recognize the decision of a subordinate court. We must have a decision of an appellate court.' 'Ah, but,' we said, 'deForest will not appeal. He acquiesces in the decision.' To which Admiral Manning replied, 'Well, that is your misfortune.'

"The Navy Department proceeded from that time to this, against our protest, ordering apparatus that embodied the patents of the Marconi Company, which had been adjudicated, and some of them subsequently adjudicated—some other patents—by the Circuit Court of Appeals. They went right on, in spite of decisions, and protests, and everything, ordering apparatus from piratical contractors.

"Well, several years ago, having got no relief whatever from this treatment by the Navy Department, we began suit against the Government in the Court of Claims to recover royalties for the apparatus which they had bought from pirates, the claims arising under the adjudicated patents; and what do you think the Government did? They not only denied our right to any royalty, but they denied the validity of the patents and required us again in the Court of Claims to go through another trial as to validity of patents which had been passed on by the Circuit Court of Appeals, although applications for certiorari to the Supreme Court were refused."

Mentioning the earlier discussion over the policy of having stations in South America controlled by the U. S. Government or private companies, Governor Griggs made the following point: "If in time of war in which the United States or The Argentine is a neutral, a private company is allowed to carry on communication with a belligerent country, it is not a breach of neutrality on the part of the country. But if a Government station in Argentina or in the United States carries on communication with a belligerent Government, it is a breach of neutrality under international law!"

Testimony by Marconi officials concluded with Governor Griggs' statement. Two full days were occupied by other wireless men, mainly in opposition. Aside from

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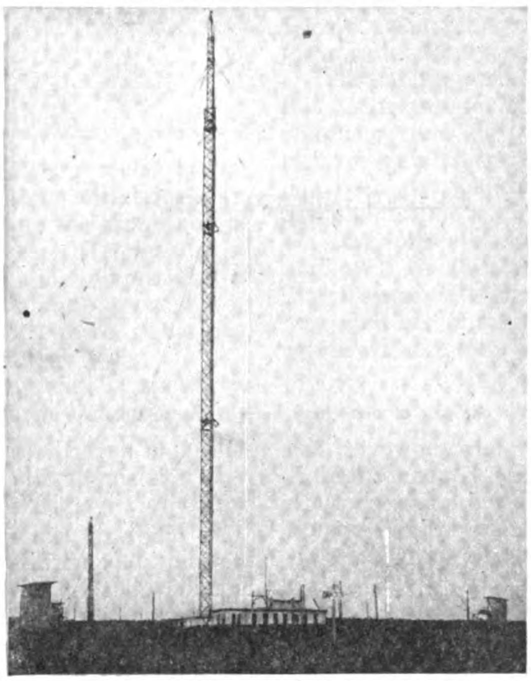
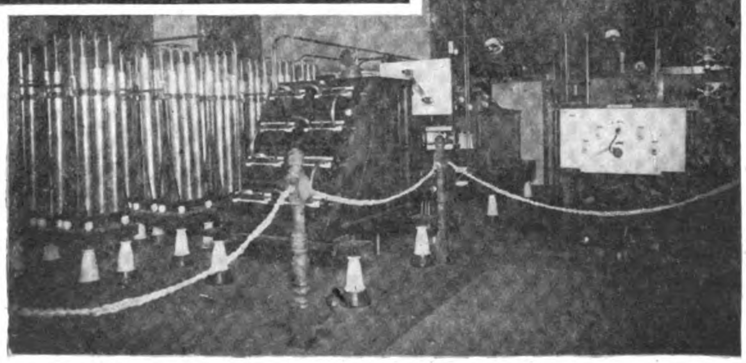


The Sayville Station



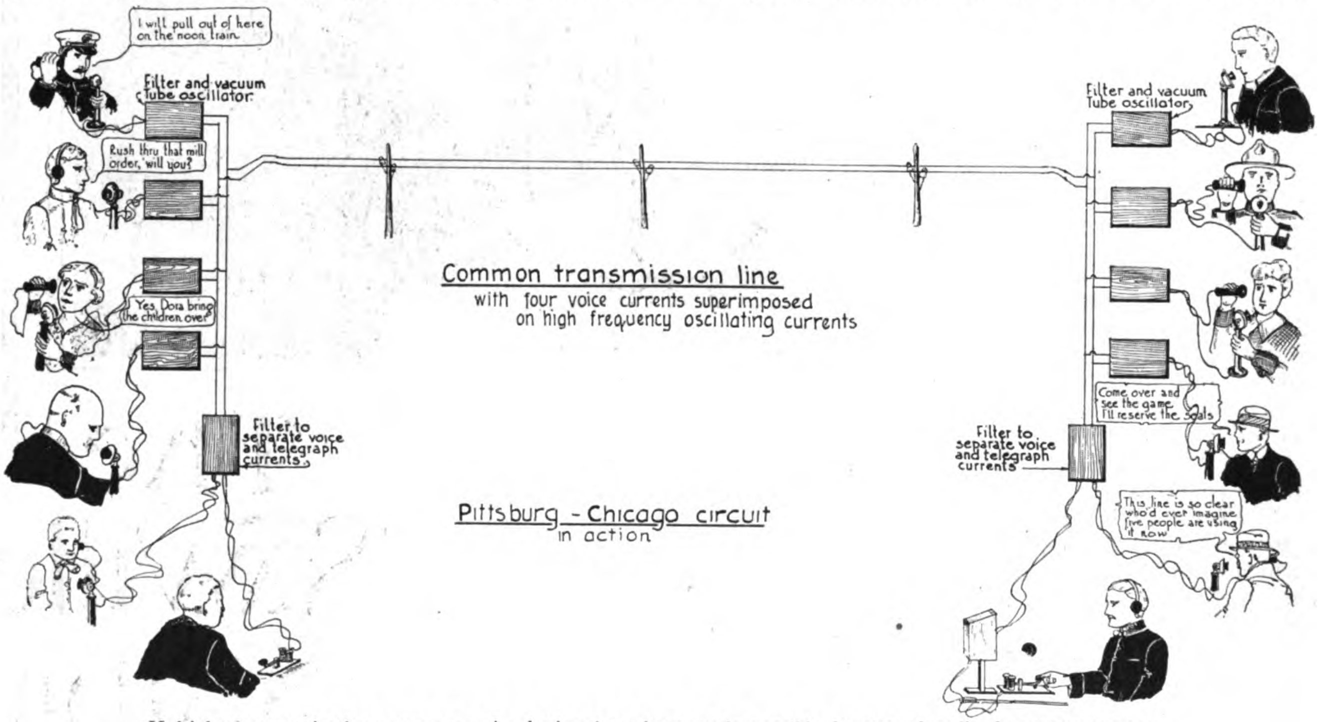
Multiplex Telegraphy and Telephony

The Use of Radio Frequency Currents

WHEN Prof. J. A. Fleming devised the two element valve for the detection of radio frequency oscillations and proved beyond all doubt its rectifying properties and moreover, when deForest and Weagant added the third electrode for further control of electron currents, they blazed the way for a series of developments which have well-nigh revolutionized both wireless and wire communication. The discoveries of Armstrong after a series of intensive experiments, in respect to regenerative amplification engaged the attention of physicists throughout the world. Numerous commercial applications of the vacuum tube followed with astounding rapidity. In fact, new inventions and further applications appeared in such numbers that it has been somewhat difficult even for the scientist to keep abreast of the times. For no sooner had one discovery been heralded forth than another appeared of possibly greater importance.

Telephone engineers were quick to foresee the possibilities of the vacuum tube in wire communication and to apply them in numerous ways to increase the efficiency of low frequency alternating currents. The three electrode vacuum tube is not only employed for the detection of damped and undamped electrical oscillations in radio but also is used as a generator of radio frequency currents at frequencies from one-half cycle to twenty million per second. Its use in cascade connection as a radio or audio frequency amplifier is well known to those engaged in radio engineering. Now-a-days, the use of five to eight tubes in cascade is common and not only are enormous amplifications obtained but the factor of selectivity, that is, discrimination between interfering wireless signals, has been remarkably increased.

Recent reports concerning the development of a novel system of wire communication whereby five telephone conversations and two telegraph messages were transmitted simultaneously over one pair of wires between Washington and Pittsburgh have arrested the attention of the newspaper reading public, but the layman is usually told that the apparatus is too complicated to be understood by the unscientific mind. This is true in a limited sense, but nevertheless the system mentioned in published reports is simply an application of well-known discoveries primarily engendered in wireless telegraph research.



Multiplex communications over one pair of wires have been made possible by use of radio frequency currents

of land line telephony. An air of mystery, however, has surrounded their experiments and the layman often is led to believe that the tube was perfected solely through their efforts. Nevertheless it was Fleming's fundamental discovery that made these developments possible, notwithstanding all arguments to the contrary.

It was the adoption of the three element electrode vacuum tube as a repeater and amplifier that made long distance wire telephony possible between New York and San Francisco; and it is because of the ease by which radio or audio frequency currents can be modulated by the vacuum tube that the modern wireless telephone has been developed to such a high degree of perfection. It is an outstanding fact that the art of wireless telegraphy is responsible for great advances in the wire communication, for many of the devices developed for radio use have been found equally applicable to wires. The tube now is being applied in miscellaneous ways in general electrical work.

The vacuum tube is susceptible to so many uses that each particular application of the tube should be the subject of a special article. The two electrode vacuum tube is now sold as a commercial article for the rectification

A diagram portraying in a non-technical manner the multiplex wire system is shown in figure 1. But the burning question of the layman is, how can several telephone currents be made to pass over the same wires and enter specific receiving apparatus without interference. It would indeed present a difficult problem were it not for the well-known resonance phenomenon encountered in circuits employing the high frequency currents of wireless telegraphy. To illustrate: If we generate radio frequency currents around 50 to 60 thousand cycles per second and we wish to impress these currents upon other circuits, the maximum current flow in the last named circuits will only take place when they are tuned to exact resonance, that is, when their natural period of electrical oscillation is identical with that of the energy producing circuit. Moreover, if we generate currents of several radio frequencies say for example, 30,000, 40,000, 50,000 and 60,000 cycles and connect them to a common line, and we provide at the distance receiving station several

circuits tuned to these four frequencies, we find that each particular frequency generated at the transmitter will automatically find its way into the receiving circuit tuned to that particular frequency and none other. The reason for this is that the circuit at the receiving station which is tuned to a particular frequency of oscillation offers the least impedance to that frequency and high impedance to all other frequencies.

Coming back to the simple wire telephone it is well known that the speech frequency currents generated in such circuits by the human voice are not only variable in amplitude, but in frequency as well. The frequencies usually lie between 200 and 2,000 per second. Imagine, then the absurdity of trying to transmit five telephone conversations each of which covered a range of several speech frequencies over the same circuit. Those familiar with the problems of telephoning will tell you that it would not be possible to weed out at the receiving station any one of these particular conversations. The question then arises, how is this done by means of the land line system so widely heralded.

We have mentioned the striking effects of resonance in radio frequency circuits and coupled with this it is well known that current frequencies above 20,000 cycles per second occur at rates to which the human ear is not

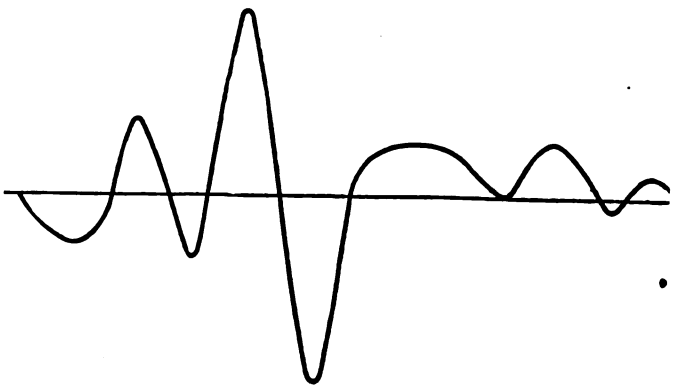


Figure 2—Oscillogram of voice-current transmitted over a telephone circuit

responsive. Consequently if a telephone receiver is employed to detect these currents, in radio or wire telephony, no sound is heard. But if we modulate the amplitude of such a high frequency current at speech frequencies by a microphone transmitter, the telephone diaphragm at the receiving station through the medium of an oscillation detector will move in accordance with these variations, reproducing the signal being transmitted.

A typical oscillogram of voice currents is shown in figure 2, the variation in amplitude and frequency being clearly indicated. The difficulty of weeding out several such currents at the receiving station is obvious. On the other hand, the unmodified radio frequency current shown in figure 3 has a definite wave form and if several frequencies are transmitted over one wire they can be weeded out at the receiving end of the line by resonant radio frequency circuits. If then, we modulate these radio frequency currents at speech frequencies by an ordinary telephone transmitter as in the oscillogram in figure 4 we obtain an audio frequency variation of the radio frequency current at the receiving station which, through the agency of the vacuum tube amplifier, appears in the head telephone as a speech frequency current. It is by this method that several telephonic conversations are carried on simultaneously without interference.

At the transmitter the grid and plate circuits of a vacuum tube are connected for the generation of radio frequency currents of any desired pre-determined frequency. Either the grid or plate circuit of the tube is connected to a microphone transmitter for speech frequency modulations of the line current. These modulated currents, whose frequency remains substantially constant, but whose amplitude varies as the frequency of the speech currents, are induced in the wire line and are weeded out at the receiving station by vacuum tube amplifiers, the grid circuits of which are made resonant to a particular radio frequency. Owing to the extreme sensitiveness of these amplifiers, very feeble line currents give good signals at the receiving station.

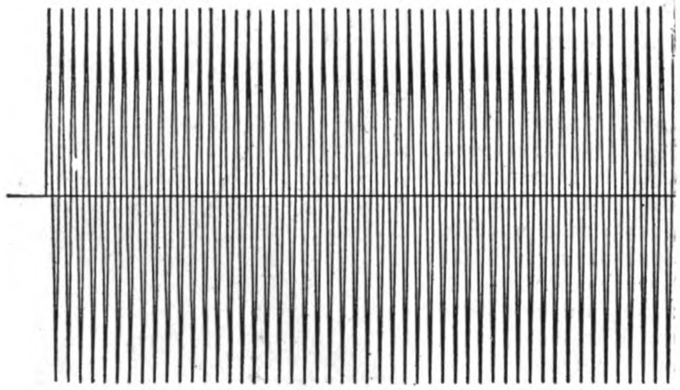


Figure 3—Oscillogram of a high-frequency current

No particular installation was made between Washington and Pittsburgh, but the toll line carrying these multiplex currents extends from the Tuxedo test station just outside of Baltimore, Md., to the Brushton station just outside the city of Pittsburgh. From Washington to Tuxedo and Pittsburgh to Brushton there are provided as many ordinary telephone circuits as are required for the ordinary and multiplex use of the toll lines between Tuxedo and Brushton—in this particular case five. These five circuits do not in any way differ from ordinary telephone circuits either from the standpoint of talking, signaling or operating. The Brushton and Tuxedo stations contain the vacuum tube generating apparatus and the current filters for the various radio frequencies.

Telegraphic currents sent over the wire do not affect this apparatus, for since these currents occur at an audio frequency and the telephone circuits are responsive to radio frequency currents only, no interference results. It has been possible for some time to take two adjacent metallic telephone circuits and to connect them to provide an additional phantom circuit. It is also possible to employ these four wires for a telegraph circuit without interference with the telephonic currents, but in the system cited two wires are employed for multiplex communication without interference. It should be understood that

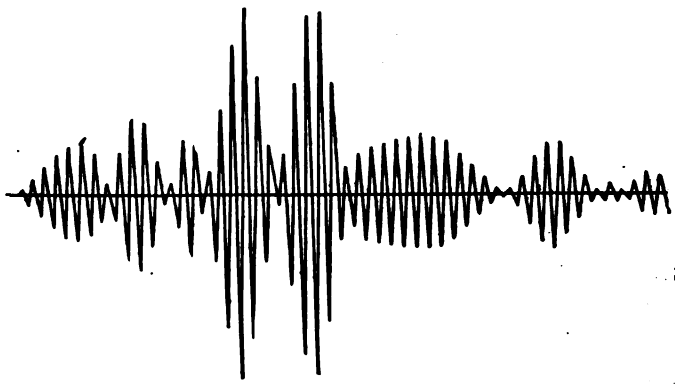


Figure 4—Oscillogram of a high-frequency current modified to transmit a voice-current

it is through the resonance phenomena accompanying high frequency alternating currents that such a system is possible and, moreover, it is the simplicity of the vacuum tube as a generator of high frequency currents and its sensitiveness as a repeater and an amplifier that makes this non-interfering common highway feasible.

It is safe to prophesy that the cable soon will employ this system of communication.

The Weagant Oscillation Valve

A Striking Improvement on the Original Fleming Oscillation Valve

Roy A. Weagant, chief engineer of the Marconi Wireless Telegraph Company

LITTLE is known of the exhaustive researches of Roy A. Weagant, Chief Engineer of the Marconi Wireless Telegraph Company of America, in connection with the design and practical application of the three-electrode oscillation valve. With the war ended it is now possible, however, to describe some features which should be of great interest to radio men. Among his numerous discoveries is a striking improvement on the original Fleming oscillation valve revealed in a recent U. S. patent. The fundamental construction of the new tube is indicated in figure 1, where a plate P and a filament F are enclosed in a vacuum chamber as usual. Mounted externally to the bulb is a metallic electrostatic control element, K, which is placed parallel to the electron stream. An essential characteristic of the tube is that the control element K is placed so that its field acts at right angles to the electron stream, for otherwise the valve becomes inoperative. It was the inability of other experimenters to recognize this all-important fact which caused their experiments to be unsuccessful. Other important factors contributing to stable operation are the spacing of the plate in respect to the filament, and the material of both.

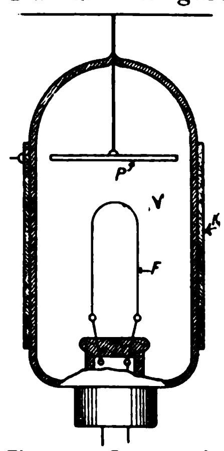


Figure 1—Cross section of the improved valve detector

Figure 2 shows an experimental type of the valve in which the plate P is a pointed piece of specially selected wire. In practice, the external element K may be plated on the glass, but it is not necessarily so attached. This tube has shown some remarkable operating characteristics, chief among them being its stability and sensitiveness as compared with previous types of bulbs. It may be employed in any of the well known circuits for cascade radio or audio frequency amplification, or regenerative amplification for damped or undamped wave reception.

A wiring diagram showing the use of the tube in a simple circuit is shown in figure 3 where the filament F as usual is heated by battery A-1 and the current regulated by the rheostat R-1. The plate circuit includes the battery, and telephone T shunted by a variable condenser C-4. The receiving transformer is indicated by the primary and secondary coils 1 and 2 respectively, with the loading inductance L-3, and the shunt condenser C-5.

In addition to the circuits generally employed in connection with three element oscillation valves, Mr. Weagant has developed the specialized circuits shown in figures 4, 5 and 6. The circuit in figure 4 can be made to generate oscillations in groups at frequencies above or below audibility and therefore can be employed for wireless reception by the beat phenomenon. In the circuit shown in figure 4 the vacuum of the tube is such that the application of 100 volts or less between the plate and filament will produce ionization. In later types of circuits a vacuum of a very high order is preferred.

An important addition to the figures 4, 5 and 6 is the use of a resistance in the plate circuit R-2 shunted by variable condenser C-3. When this resistance is of the order of that of the internal resistance of the tube, it enables the operator to obtain an adjustment so that minute electrical impulses impressed upon the tube cause a great increase in current through the telephone T. This resistance contributes materially, in tubes of low vacuum, in obtaining an adjustment whereby automatic interruption of the local plate current is secured, causing the valve to generate alternating currents in groups. The inductance 3 in figure 4 gives marked amplification of the incoming signals. By its use, the frequency of the plate circuit may be adjusted to correspond closely to that of the grid secondary circuit. Connected in this way, the valve generates sinusoidal oscillations with-

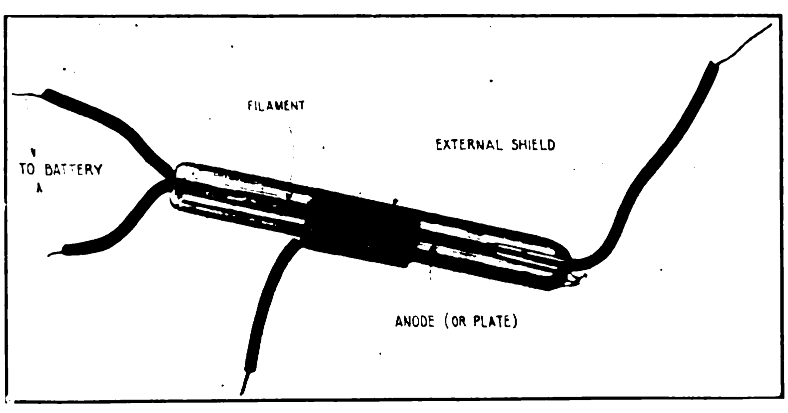


Figure 2—Experimental type of Weagant's oscillation valve

out depending upon ionization and the tube is therefore preferably highly exhausted. The more perfect the vacuum the better the results.

When the apparatus in these diagrams is employed for the reception of spark signals their circuits are adjusted just to the verge of oscillation, but for undamped waves, they are set into oscillation at frequencies slightly different from that of the incoming signal producing beat currents.

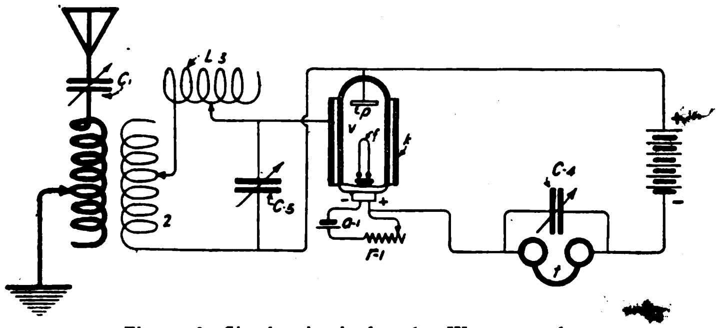


Figure 3—Simple circuit for the Weagant valve

An odd circuit devised by Weagant which is productive of good results is that shown in figure 5, where the antenna is coupled to the plate circuit rather than to the grid circuit. Coupling between the plate and secondary circuits is provided by the wire 10 tapped on to the coil 3. This circuit is applicable to the production of powerful oscillations for transmitting purposes. The modified circuit in figure 6 shows electrostatic coupling between the secondary and plate circuits through the medium of condensers.

Tubes of this type prove very efficient as generators of undamped oscillations for radio telegraphy or telephony.

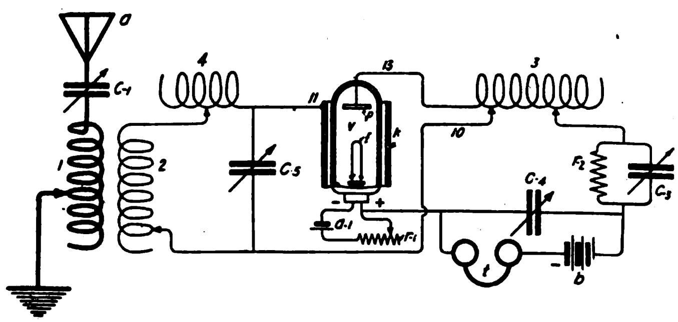


Figure 4—Circuit for damped or undamped wave reception

Tubes giving an output current of 50 watts have been constructed. They are found to operate continuously with great stability. A battery of such tubes may be connected in parallel with good results. Any of the circuits heretofore employed in connection with cascade amplification are thoroughly applicable to the improved valve with the external control element.

Very basic claims have been granted to the patentee. The specifications were filed April, 1915, and granted December 31, 1918. Extensive experiments were made previous to the filing of the application and it is therefore obvious that the work of Mr. Weagant antedates the experiments of all other investigators in this particular branch of radio. The scope of some of the claims may be understood from the following quotations:

"In a vacuum tube device, a vacuum chamber, two elements within said chamber, means for heating one of

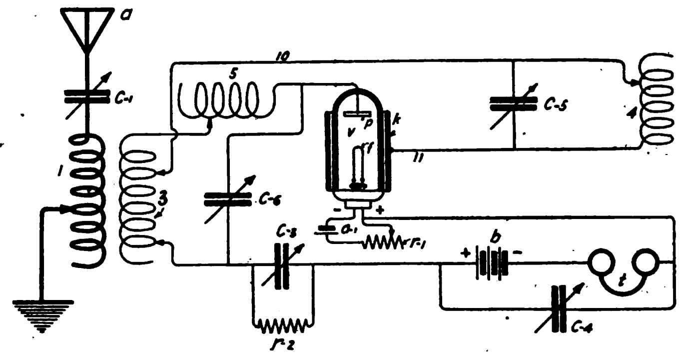


Figure 5—Circuit for transmitting or receiving purposes

said elements, means for producing an electron stream between said elements, an electrostatic control element outside said chamber, the field of force of the outside element being at an angle to the electron stream between the interior elements and the outside element being located near enough to the source or stream of electrons to usefully vary the space charge due to said stream.

"A radio frequency signaling device comprising a vacuum chamber containing two elements, means for heating one of said elements, and an electrostatic control element outside said chamber, the electrostatic field due to said control element being at an angle to the electron

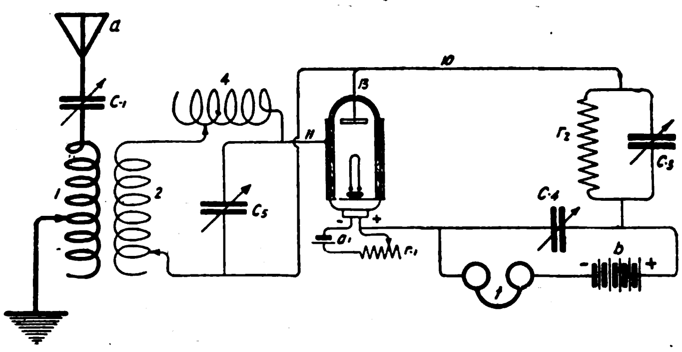


Figure 6—Simplified circuit for beat reception

stream within the vacuum chamber and thereby capable of producing useful variations therein.

"A radio frequency signaling device comprising a vacuum chamber containing means for producing a stream of electrons, and an electrostatic control element outside said chamber adapted to project a field of force into the space within the chamber at an angle to said stream of electrons."

Practical Wireless Instruction

A Practical Course for Radio Operators

By Elmer E. Bucher

Director of Instruction, Marconi Institute

PART II—ARTICLE III

Editor's Note—Part 1 of this series of lessons began in the May, 1917, issue of The Wireless Age. Successive installments were devoted to the fundamental actions of radio transmitting and receiving apparatus for the production and reception of damped oscillations.

Part 2, the present series, will deal with undamped wave generators, including bulb transmitters and receivers for the reception of undamped oscillations. The direction finder and other special appliances employed in radio telegraph work will be treated fundamentally. A discussion of the basic principles of wireless telephony will terminate the series.

The outstanding feature of the lessons has been the absence of cumbersome detail. The course will contain only the essentials required to obtain a government *first grade commercial license certificate* and to supply the knowledge necessary to become a first rate *radio mechanic*.

RADIO FREQUENCY CHANGERS

(1) In the two types of radio frequency alternators previously described—the Alexanderson and Goldschmidt machines—currents of the correct frequency for direct connection with the antenna circuit were generated within the machines, but in the system now to be described, a comparatively low frequency alternator is employed to generate the initial radio frequency current, the frequency being increased by means of **mono-inductive transformers** termed **radio frequency changers.**

(2) The principal advantage of the frequency changer system lies in the fact that since the initial frequency generated by the alternators is comparatively low, the generator armature may rotate at reduced speed, and the problem of design is accordingly simplified. Then by means of specially designed transformers, the frequency is increased to a suitable value for the various wave lengths employed in radiotelegraphy.

(3) The efficiency of the system decreases considerably as the number of steps is increased. But these transformers provide a fairly simple means for increasing the oscillation frequency, and permit a non-arcing control of the antenna currents—a desirable feature in high power transmitters.

(4) Various systems of frequency transformation have been devised, but it seems that the Joly-Arco or the Arco-Meissner systems are favored for commercial use, but they have not been widely adopted.

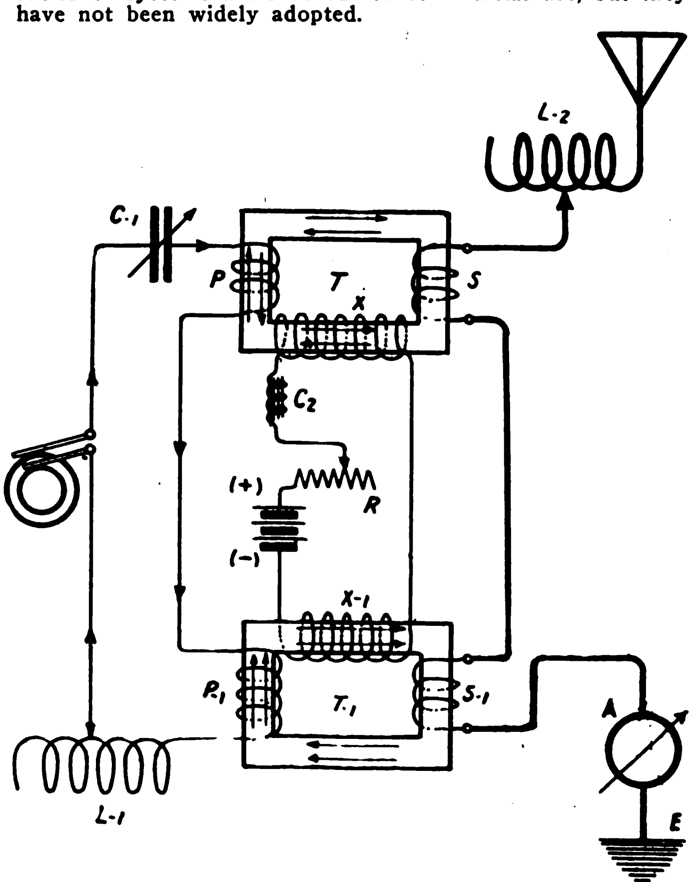


Figure 196

OBJECT OF THE DIAGRAM

To show the fundamental circuits of a single step radio frequency changer.

DESCRIPTION OF THE DRAWING

The radio frequency alternator to the left of the drawing generates at the frequency of 10,000 cycles per second. It is connected through the condenser C-1 and the inductance L-1 to the primaries P and P-1 of two radio frequency transformers T and T-1, respectively. Their secondaries S and S-1 are connected in series and in series with the antenna system comprising the loading inductance L-2, an aerial ammeter A and the earth connection E. Two DC excitation windings X and X-1 fed by a storage battery or DC generator are employed to saturate the cores of T and T-1. A regulating rheostat R enables close regulation of the core magnetism.

OPERATION

By proper disposition of the primaries P and P-1 and keeping in mind that the cores of T and T-1 are fully saturated by the DC winding, it is evident that the **transformer cores act inductively upon the secondary only when the current through their primaries flows in a certain direction.** For when the flux generated by the primary winding P-1, for a complete half cycle of the radio frequency current from the alternator, flows in the same direction as the flux supplied by the DC excitation winding, there is practically no increase in the core magnetism and consequently no effect upon the secondary winding S-1. But at the same time the flux generated by the primary winding P opposes the flux in the core T and a peaked reduction of magnetization takes place as will be shown in figure 201. **This reduction of flux followed by subsequent increase to the normal degree of saturation (which occurs upon the termination of the half cycle) induces a cycle of current in the secondary winding S.** For the next half cycle from the radio frequency alternator, transformer T-1 becomes active and transformer T inactive. **Therefore, for every complete cycle fed to the transformers by the radio frequency alternator, two complete cycles are induced in the antenna system.** The antenna frequency of a 10,000 cycle alternator will be 20,000 per second corresponding to the wave length of 15,000 meters.

SPECIAL REMARKS

(1) Each transformer in the frequency changing system comprises an annular or rectangular closed **iron yoke** composed of **thin laminated iron sheets** so constructed that each part is seamless and has the form of the complete yoke. The thickness of the sheet decreases with increase of frequency.

(2) The variation of flux generated by the alternator has a tendency to induce high voltages in the excitation windings fed by the DC dynamo. To reduce these E.M.F.'s to a safe value, the excitation coils are divided into groups connected in parallel. A DC excitation generator of low voltage is then employed.

(3) Maximum efficiency is secured from frequency changers when the effective number of ampere turns for the radio frequency winding is approximately equal to the ampere turns of the DC winding. The former should not exceed the latter by more than 20 per cent.

(4) Magnetic leakage must be reduced to a minimum, likewise the iron and copper losses. The windings must be uniformly placed over the whole length of the yokes and in case of very large powers, the iron yoke should be constructed of individual insulated packs of sheet metal with intervening air spaces. The transformer is then submerged in oil which is forced between the windings and the packs of sheet metal.

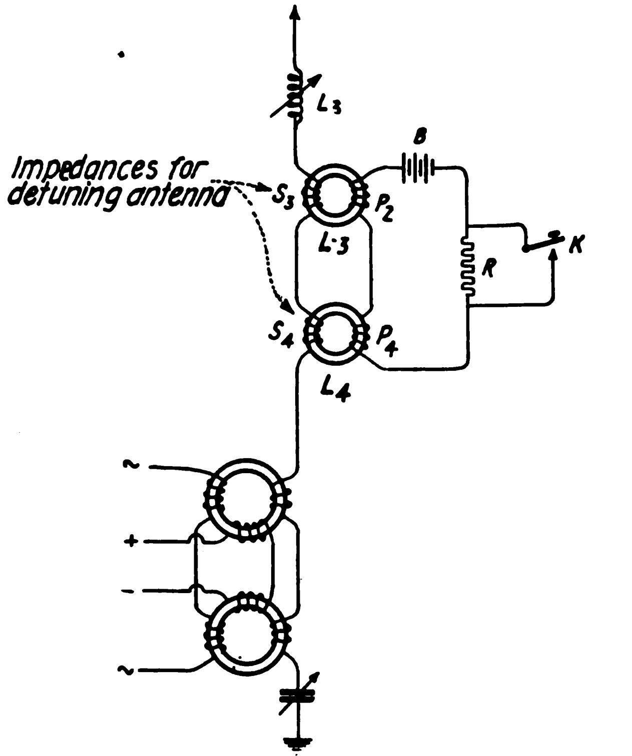


Figure 197—Method of controlling the antenna current, suggested by Arco and Meissner. One way impedances L-3 and L-4 have their secondaries connected in series with the antenna. Their primaries P-2 and P-4 are connected to the direct current source B which also includes the resistance R and the shunting key K. By proper adjustment of the DC magnetising current through P-2 and P-4, the self-induction of the windings S-3 and S-4 may be made to vary greatly simply by change of flux through the iron. Hence, the electrical constants of the antenna circuit can be so selected that when the key K is closed, the self-induction of S-3 and S-4 is reduced by such an amount as to place the complete antenna system in resonance with the last group of radio frequency changers. But one secondary winding is active in impeding the antenna current for a half cycle, that is, the winding S-3 impedes one half cycle and the winding S-4 the following half cycle.

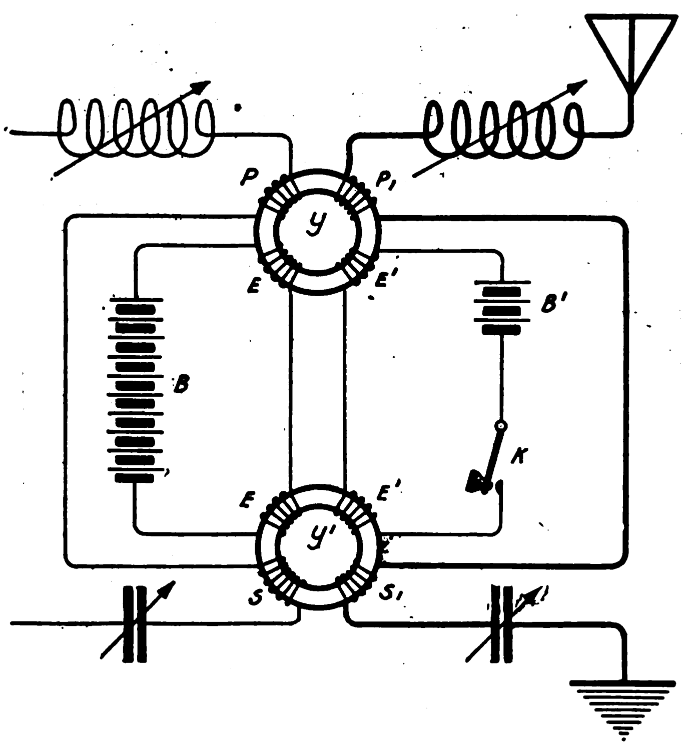


Figure 198—Divided control circuit of the Arco-Meissner system in which the cores of the last step of radio frequency changers are partially saturated by the DC excitation windings E, E, fed by the battery B. The coils E', E', provide the additional magnetising force required to saturate the core or to control the flux in the yokes Y and Y-1 in accordance with any particular set of requirements. The key, K, may be replaced by a magnetic interrupter for producing tone frequency signals or a battery of microphones for speech transmission may be placed in the same circuit to vary the antenna currents at speech frequencies.

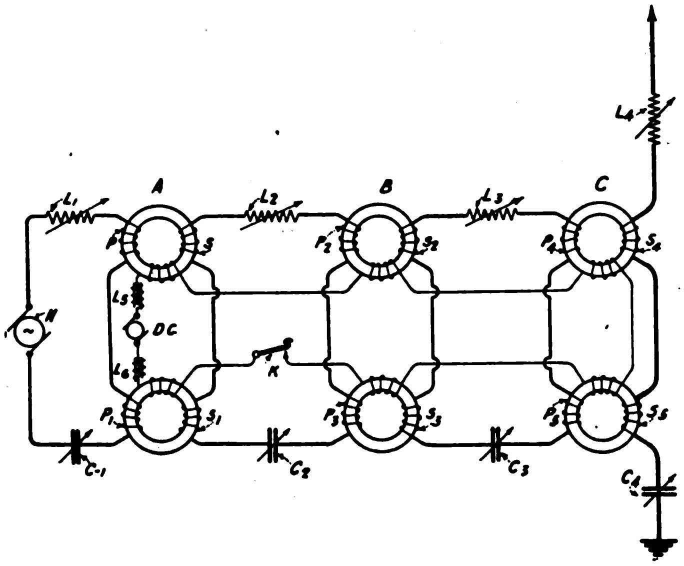


Figure 199

OBJECT OF THE DIAGRAM

To show the circuits of a three-step radio frequency changer system.

DESCRIPTION OF THE DRAWING

Three groups of **frequency transformers** A, B and C are connected in cascade. They are fed from a direct current source marked DC which through their excitation windings **saturate** the cores. The inductances L-5 and L-6 serve to prevent the flow of radio frequency currents back to the DC generator. The primaries of group A are connected to the radio frequency alternator N as usual. Secondaries S and S-1 of group A are connected to the primaries P-2 and P-3 of group B. Similarly, the secondaries of group B are connected to the primaries of group C. The secondaries of group C are connected to the antenna system.

The intermediate circuits of the transformers A, B and C are tuned to the requisite oscillation frequency by inductances L-2, L-3 and condensers C-2, C-3. A key K is inserted in the DC excitation circuit for signaling purposes.

OPERATION

If the frequency of the alternator N is 10,000 per second, a frequency of 20,000 will be developed in the secondary of group A which will be increased to 40,000 in the secondary of group B and to 80,000 in the secondary of group C. The antenna is carefully tuned to the latter frequency which corresponds to the wave length of 3,750 meters. The operation of this method is no different than that explained in connection with figure 196 except that three steps are connected in cascade. Resonance with the alternator frequency is obtained by the variable inductance L and variable condenser C-1, that is, the complete circuit N, L-1, P, P-1, C-1 is made resonant to the alternator frequency. Similarly the circuit S, L-2, P-2, P-3, C-2, S-1 is made resonant to frequency of 20,000 cycles, and the circuit S-2, L-3, P-4, P-5, C-3, S-3 to the frequency of 40,000 cycles. The antenna system is tuned to resonance with the last named frequency by the variable inductance L-4 and variable condenser C-4.

SPECIAL REMARKS

(1) To simplify the process of tuning, Arco and Meissner have shown a circuit wherein variable resistances are included in the radio frequency circuits to **decrease the sharpness of resonance.** After the resonance adjustments are roughly made the resistances are cut out until maximum resonance is secured.

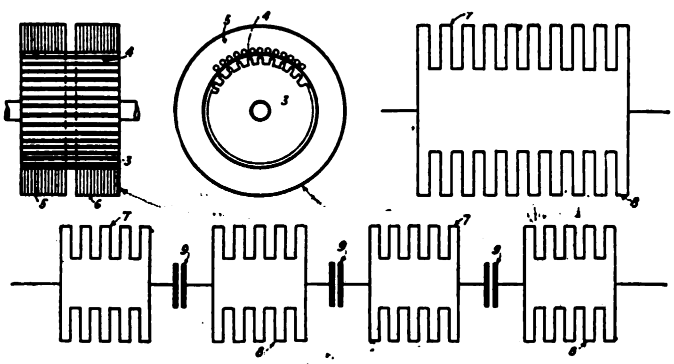


Figure 200

OBJECT OF THE DIAGRAM

To show the constructional details of the Arco-Meissner radio frequency alternator.

DESCRIPTION OF THE DRAWING

The rotor indicated at 3 consists of a **toothed wheel without windings** driven at a very high speed. The poles which are formed at the teeth are of equal polarity and the **generation of radio frequency currents** is secured by **undulations of flux** and not by a reversal which is the case of an ordinary alternator.

It has been found to contribute to the efficiency of the generator to divide the generator systematically in the middle at right angles to the rotor axis so that equal stator halves 5 and 6 are obtained.

As shown in the detail in the upper right hand corner, the windings of the two winding halves 7 and 8 are preferably arranged in parallel in order to reduce the self-induction of the generator and to keep the voltages developed by resonance within a safe value. In order to reduce further the difficulties of insulation due to high voltages, **each stator half in generators of high power is divided into an equal number of sections** and the two corresponding sections of the two armature halves are in each case arranged in parallel as a group as shown in the lower part of the drawing.

The resulting groups are preferably arranged in series with condensers 9 placed between each group. This arrangement reduces materially the equalizing currents which occur in the parallel arrangement of the armature halves due to slight inequalities of the winding. By this design the voltage between the entire windings and the stator is no greater than the voltage between an individual partial winding and the stator.

In generators of large power, means are provided for conducting cooling water through the iron of the stator.

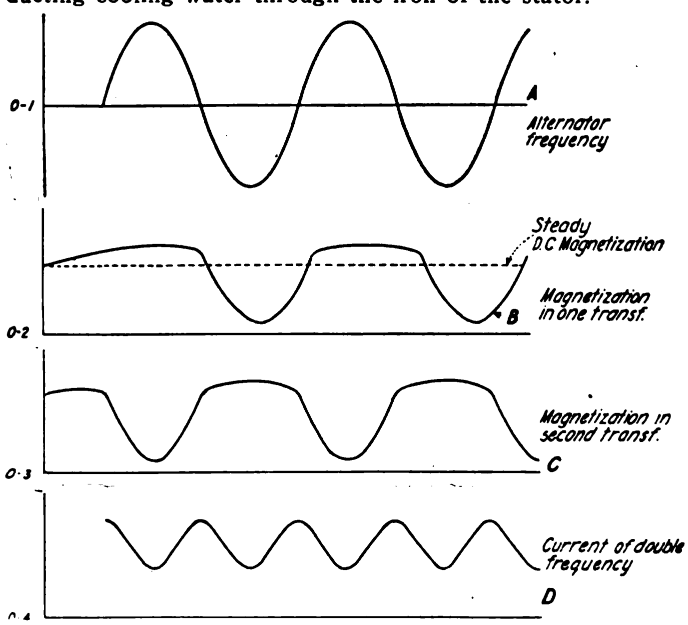


Figure 201—Series of curves showing graphically the phenomena involved in the induction of currents in the frequency changer system in figure 196. Graph O-1 indicates the alternator frequency and the dotted line in graph O-2 the steady DC magnetization in the cores. The curve B in graph O-2 shows the magnetization for a half cycle in one transformer and the curve C of the graph O-3 the magnetization in the second transformer. When the flux generated by the radio frequency current has the same direction as that in the DC excitation winding, the core magnetism is slightly increased, but when these fluxes oppose, a large reduction occurs which induces currents of double frequency in the secondary winding. This current is shown in the graph O-4.

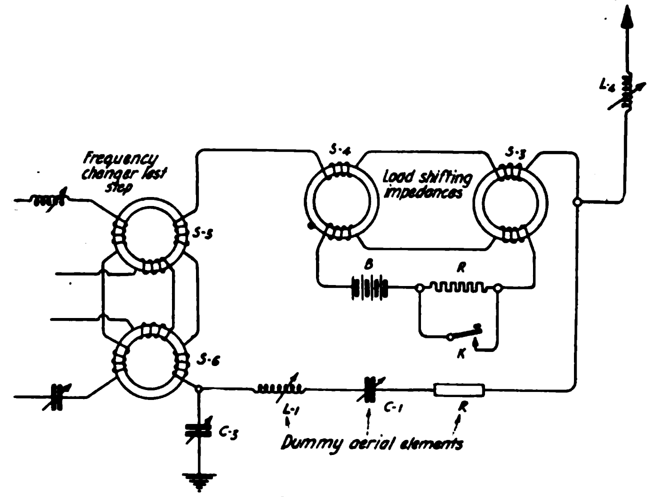


Figure 202

OBJECT OF THE DIAGRAM

To indicate the circuits of a load shifting device whereby the output of a radio frequency alternator is alternately shifted from the antenna circuit to a dummy aerial circuit during a signaling period.

PRINCIPLE

Detuning of the antenna circuit would, in the ordinary system, take the load off the radio frequency alternator whenever the signaling key is open. This may cause the alternator to increase its speed to such a value that it will be out of resonance with the antenna circuit, but if the load is shifted to an artificial antenna circuit during the non-radiating periods of the antenna circuit, the speed and output of the alternator remain constant.

DESCRIPTION OF THE DRAWING

The load shifting impedances are indicated at S-4 and S-3 which perform the same function as those indicated in figure 197. There is shunted around these impedances **an artificial aerial circuit**, including the inductance L-2, the variable condenser C-1 and the ballast resistance R.

OPERATION

The inductances and capacities of the antenna system and of the dummy aerial circuit are selected so that when the key K is closed, the **self-induction of S-4 and S-3 are reduced by an amount that will place the antenna system in resonance with the radio frequency changers.** Simultaneously the reduction of the self-induction of S-4 and S-3 detunes the artificial aerial circuit permitting the normal flow of antenna current. When the key K is raised, the reverse operation takes place, the load circuit being placed in resonance with the radio frequency changers and the antenna detuned.

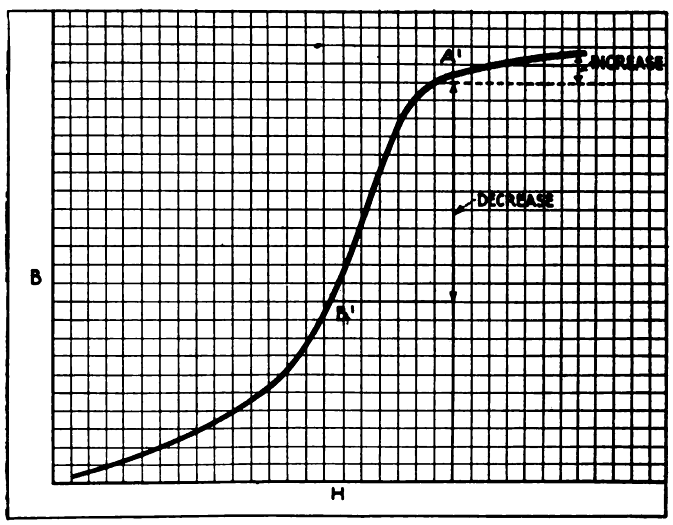


Figure 203—Characteristic magnetization curve of transformer core. H represents the ampere turns of the DC winding, and B the resulting flux through the core. Point A' called the "knee" of the curve, is approximately the point of saturation. It is clear from the curve that if the flux of an alternating current is superimposed upon DC flux (while the DC magnetization is adjusted to the point A'), one half cycle of the alternating flux will cause a slight increase in the total core flux and the next half cycle a marked decrease.

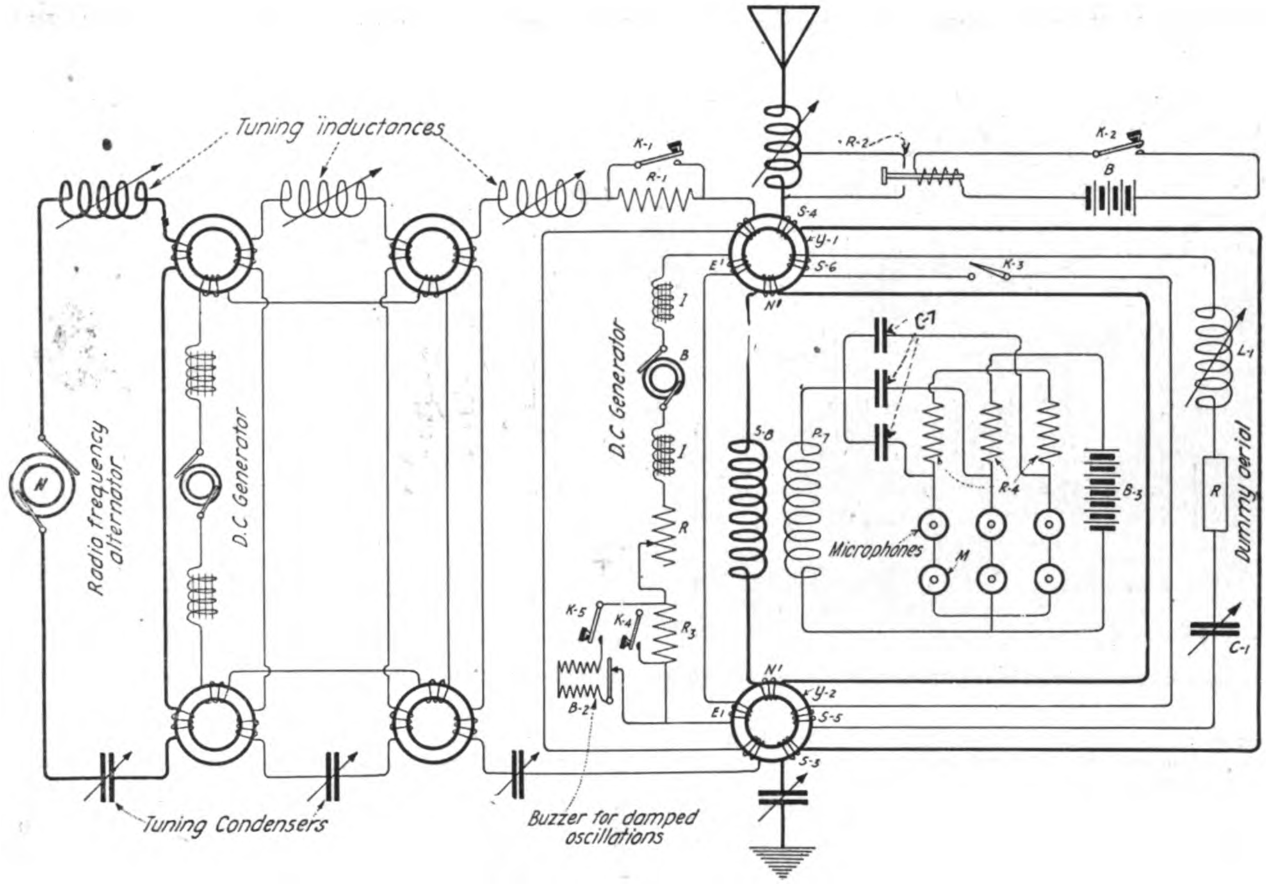


Figure 204

OBJECT OF THE DIAGRAM

To indicate the complete circuits of the radio frequency changer transmitting system for telegraphing by damped or undamped oscillations, or for wireless telephony.

DESCRIPTION OF THE DRAWING

The radio frequency alternator N is connected to the primary circuit of a three-stage radio frequency changer system, the last state being fitted with special circuits for **control of the antenna currents at speech frequencies, for the production of tone frequencies (damped oscillations), for telegraphy by undamped oscillations, and a special artificial aerial for maintaining a constant load on the generator.**

The cores of the first two groups of radio frequency changers are saturated by one DC generator and the cores of the last group by a second DC generator indicated at B which is protected from radio frequency currents by the iron core chokes I, I. A regulating resistance R is included in series to adjust the magnetism of the cores of the last group.

Several methods of signaling are provided, for example, **telegraphy by damped oscillations** may be accomplished by the key K-4 shunting resistance R-3, or for the **production of tone frequencies** the key K-5 and buzzer B-2 are employed. For **speech transmission** the microphones M coupled to the audio frequency transformer P-7, S-8 are employed to vary the magnetism of the cores of the last group. **Telegraphy by undamped oscillations** again may be accomplished by the key K-2 which operates the relay R-2 and in case of high powers the keys K-1 and K-2 are operated in unison to prevent the development of disastrous voltages in the circuits. An artificial aerial is also provided to maintain a constant load on the generator, that is, the key K-3 may be closed and when key K-4 is operated for signaling, the generator output is automatically shifted from the antenna to the artificial aerial. The artificial antenna circuit includes the key K-3, winding S-6, variable inductance L-1, the load R, variable condenser C-1 and the winding S-5.

OPERATION

As usual the frequency of the alternator N, through the three steps of frequency transformation, is increased four times, that is, if the alternator frequency is 10,000 per second, the antenna current will be 80,000 per second.

The alternator circuit and the intermediate circuits of the frequency changers are tuned by the variable condensers and inductances as heretofore explained.

In case of low powers, telegraphy by undamped oscillations may be effected by closing the key K-2 which operates the relay R-2, the latter shunting a portion of the aerial tuning inductance to place the antenna system out of resonance with the alternator. The key K-1 shunting resistance R-1 is worked in unison with the key K-2 to prevent the development of high voltages in the radio frequency changers. Thus, when the antenna is detuned the sudden insertion of the resistance R-1 prevents the phase shifting of the current and voltage from generating disastrous voltages.

For large power outputs the key K-4 may be employed to saturate and de-saturate the yokes of the last group of radio frequency changers. For the production of damped oscillations a buzzer B-2 in series with the key K-5 shunts R-3 and the resulting changes of flux through the yokes is sufficient to modulate the antenna currents at audio frequencies. The radiated energy is then of the proper characteristic for reception by oscillation detectors suitable to damped oscillations only.

For **speech transmission,** the microphones M are connected to their source B-3 and the resulting changes of current are made to act upon the primary P-7 through the condensers C-7. The speech currents induced in S-8 vary the magnetization of the core sufficiently to modulate greatly the output or antenna current. Two microphones are connected in series and three such sets are connected in parallel. Each microphone group is shunted by winding P-7 of the telephone transformer and each branch includes one of the condensers C-7. The operation of the microphone control is as follows: Whenever microphone resistance increases, the current through its series resistance remains nearly constant, but the current through the microphone diminishes. The excess current therefrom flows through the primary winding P-7 and the corresponding condenser.

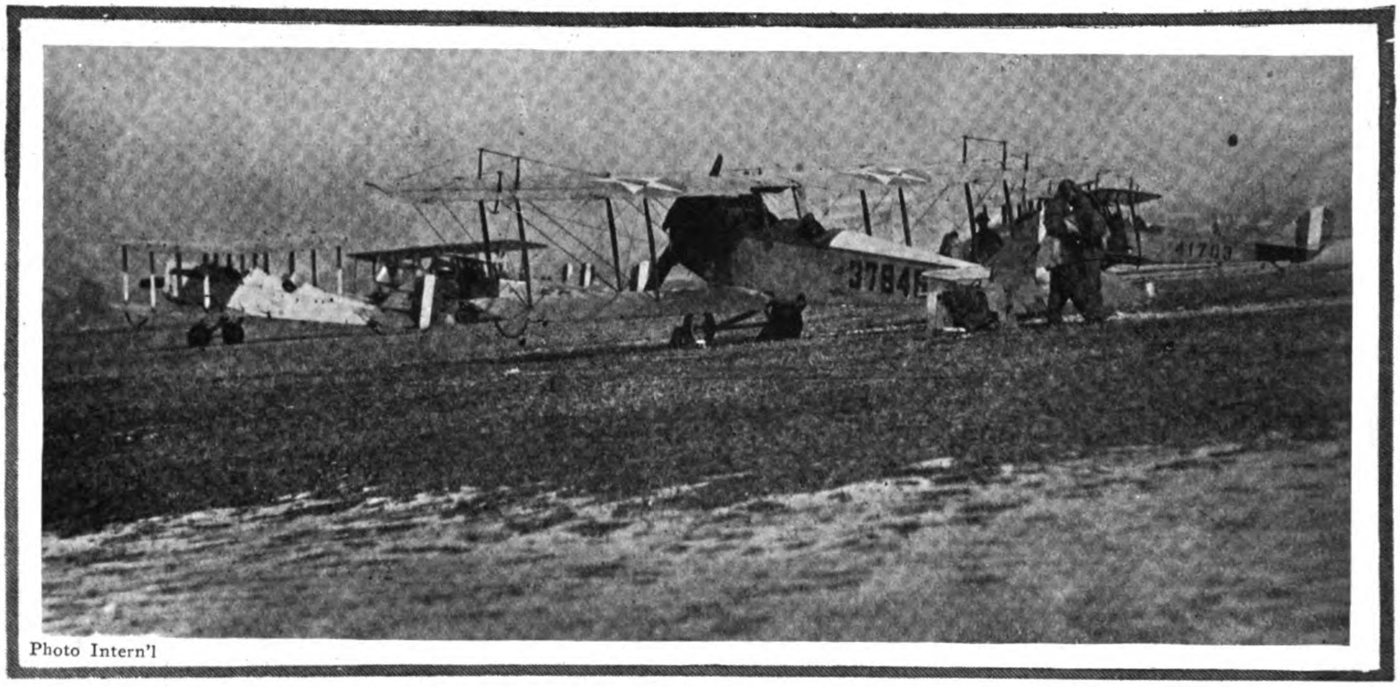


Photo Intern'l

Above: the finish of a coast to coast flight showing four U. S. Army airplanes which flew from San Diego, Cal., to Mineola, near New York City, for the purpose of mapping out a transcontinental aerial mail route; the distance covered was 4,200 miles in 53 flying hours

To the right: listeners of the British Navy using one of the inventions developed during the war which made possible the faculty of hearing the approach of submarines

Below: Capt. R. W. Schroeder, U. S. A., wearing the oxygen helmet necessary in making his altitude flight to 28,900 feet above sea level

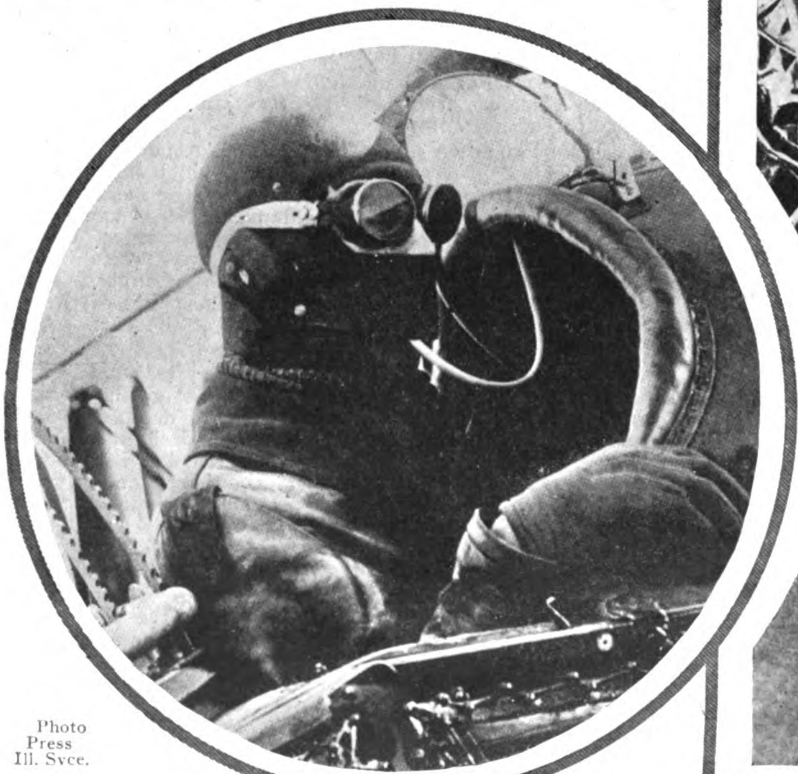


Photo Press Ill. Svce.

Photo Intern'l

The Monthly Service Bulletin of the NATIONAL WIRELESS ASSOCIATION

Founded to promote the best interests of radio communication among wireless amateurs in America

GUGLIELMO MARCONI, President J. ANDREW WHITE, Acting President ALONZO FOGAL, JR., Secretary

Headquarters, 25 Elm St., New York

The Amateurs' Services Have Been Invaluable To Our Country

I SEE no reason whatsoever why the Government should not permit amateur stations to re-open immediately.

In modern warfare wireless plays an important part on land, water and air. One can say that it forms the nucleus of efficient warfare. Therefore, when war was declared by the United States against Germany, and the army and navy was put on a war basis, very many positions, requiring a knowledge of wireless telegraphy were automatically opened.

To teach men the rudiments of wireless telegraphy would require time. So the United States turned her gaze upon the many amateurs in the wireless telegraph field and called upon them to help her out of the predicament. The amateurs responded nobly to the call. Many of them have given the supreme sacrifice. But they were glad to give it for they gave it for the United States—the land of liberty and justice.

To fail to recognize the right of amateurs, earned by bloodshed and death, to immediately have their stations opened would make many fellows feel that their country, the land of freedom, was not treating them fairly and living up to its name. And this would be a calamity.

Why not open up the amateur stations and show that our Government realizes that the boys of the "dots and dashes" did their bit and did it *nobly*.

JOHN KULIK—*New Jersey.*

A Reason for Re-opening Amateur Stations

WITHOUT the help of some thousands of radio enthusiasts the task of efficiently training the necessary personnel to man our ships and furnish the Signal Corps with proficient radio operators or electricians would have been an impossibility, particularly if we consider the demand for men and the lack of facilities for their immediate training.

I can state emphatically from my own experience that the former radio amateur was more easily trained into a proficient operator than his running partner, the telegraph operator.

The help which was so quickly forthcoming from the radio amateur should be sufficient to convince the Government that to permit amateur stations to re-open, will in itself, constitute an indirect expression of their appreciation of the amateur's good services.

HENRY E. BARTON—*New York*

Plan for Organization Indorsed

To the Editor:

Mr. Batcher's plan in the February issue for organizing the amateur interests by states is a splendid idea, in fact it seems to present a great similarity to the plan I have in mind for the organization of amateurs of the state.

My plan would be to divide the state in about four sections, each section to have its board of directors and jurisdiction in that vicinity only; to have also a state board of directors, allow each district to furnish the necessary officers for the board, as President, Sec'y.-Treas., Corresp. Sec'y., and Publicity Sec'y.

If the state has four districts, the necessary officers for the state board of direction can be alternately furnished by each district. The state to have a national representative, this member to be chosen by the state council from amateurs within the state. Of course, to begin with, the organization must be incorporated within its state, also must have sufficient funds and working capital for bulletins, etc.

It seems to me that too many local bodies would be as much of a failure as having one too large, but I think that most any state organized into four districts would make in a majority of cases, a local body with lots of pep and stamina; but it may look too large, if one stops to consider that a number of towns do not possess any amateurs whatever.

Our one big blow! Can we find our Philanthropist of the art of radio science? Of course, some of the expenses can be met by dues from the membership, the exact amount being governed by the class of membership held.

I certainly agree with Mr. Batcher that amateur bodies must be formed, so as to be perfected on the resumption of the amateur privilege.

L. N. WAY, *Michigan.*

Why Not Recognize Our Constitutional Rights?

EVERYONE who is personally familiar with radio in all its phases, knows many reasons which would justify the re-opening of amateur stations upon the conclusion of peace. Among these are the services rendered by the so-called "amateurs" in the war, the development of radio resulting from investigation conducted by amateurs, the supply of radio operators for national defence in the future, the wholesome effect upon boys and young men exercised by the study of the art, the employment of capital and labor manufacturing apparatus, and many others.

These reasons have been often cited, and as I remarked above, any one of them would more than justify again opening the amateur stations, but these reasons are all based upon the insecure argument of expediency, while there is another that is more basic and rests upon the secure foundation of principle; it is that we live under a government "Of the people, by the people, and for the people"—nothing less.

Now if our principles as a nation recognized "Government of the people, by the Government," or "Government of the people by the Navy," the permanent closing of amateur radio stations might be legal and proper, but as we live under a government "of the people, by the people, and for the people," it is not, and the stations must therefore be re-opened.

In war, drastic powers are necessarily delegated to the various departments of the Government, but in peace it is different, and we should not for one moment forget that the army and navy exist only to defend the people and enforce their will, and not to rule them and devise regulations for their conduct. This is the first principle of our country, and should be indelibly stamped in the heart of every American.

All this being true, the most important reason why the amateur radio stations should be re-opened is because the amateurs *want* them re-opened, and have a *right* to have them re-opened.

JOHN V. PURSSELL—*Washington, D. C.*

The Fire Underwriters' Rules Applied to Amateur Stations

AMATEUR wireless apparatus often is not installed in accordance with the Underwriters' rules and in a few cases the violations are so serious that it constitutes a fire hazard. As a rule, radio amateurs are willing to adopt any changes which are suggested to them that will better their stations if it is within their means, but the conditions necessary for safe and satisfactory service from their power wiring, are only vaguely understood. It is the purpose of this article to point out the advisability of modifying the installation to conform to the Underwriters' rules, and the method of doing so. If the suggestions are acted upon, the fire risk will be materially reduced.

In many amateur stations the circuits supplying current for the high voltage transformer of the experimental radio transmitter are given little or no attention, and consequently the majority of stations are not as perfect as they might be in this respect. The wiring is sometimes installed in a slipshod fashion from a miscellaneous assortment of material that is unsuited for the purpose. Improper insulation of conductors from each other and surrounding objects, insufficient carrying capacity of conductors, absence of proper protective devices and overloading of circuits are the main shortcomings. It is not uncommon to find wiring that could hardly be considered of sufficient current carrying capacity for battery current, supplying a 1 kw. transformer and a rotary gap besides. The service rendered by such poor construction is usually very unsatisfactory, causing excessive drop in voltage at the transformer terminals, blinking of lights and other annoyances, not to mention the fire hazard sometimes incurred.

In planning the reconstruction of his station, the progressive experimenter should give this subject due consideration and take steps to remedy any defects that may exist in the circuits of his power supply. Of course the chief consideration regarding the installation is that it shall comply as nearly as possible with the rules of the Fire Underwriters, and if these conditions are met even half way a comparatively safe and satisfactory condition will obtain.

If your transformer is of 1 kw. it would be well to first ascertain whether or not the house meter has sufficient capacity to carry the full load plus that of the rotary gap and about half the house lighting load simultaneously. This precaution may save an extended argument with the power company or perhaps the price of a new meter. It is the general practice to install only a 5 ampere meter in residences, since they can stand a 100 per cent overload. It is always good policy to notify the electric company of your new load, and if they do not believe it to be necessary to change the meter, it becomes their risk and if the meter is burnt out it is their loss. I mention this because I had to "kill" two meters before the local electric company consented to installing one of increased capacity. No doubt other experimenters have had their troubles in this respect.

If the transformer is on an upper floor of the house, some distance from the meter, it is usually the practice to tap into a convenient fixture or base board receptacle, or else run a short feed which is tapped onto the lighting circuit wires at some point in the room. This should not be done since it is forbidden by the Fire Underwriters. The wiring of the average house is seldom larger than No. 14 B. & S. and in the fixtures it is usually No. 16 or No. 18 B. & S. The voltage at the transformer terminals will be low, and all lamps on that circuit or on the same feeding wires will flicker badly. Choke coils and other paraphernalia are usually resorted to in an effort to prevent this, but they can never be of great value so long as the current is taken from the fixtures. Furthermore no lighting circuit is supposed to carry more than 660 watts, so it is evident that the only method sanctioned by the Underwriters is to run a separate pair of feed wires of proper size to carry the current without excessive drop in voltage, from the meter direct to the transformer terminals. There should be an individual fuse block for these feed wires mounted either at the meter or else in the radio room where it would perhaps be handiest to replace a blown fuse without going down to the cellar while you tell the other fellow to stand by. This usually is done by the light of a candle, as the house lights are out as well.

It will be found a good investment to run separate feeds, as you have done the right thing by the Underwriters, the lights will not flicker and the lights in the house will not go out every time you blow a fuse. This will give the home folks a vastly better opinion of "wireless." The size of these feeds will be governed by several factors; the current in amperes taken by this transformer, the distance of the transformer from the meter, and the loss in volts that is permissible in carrying the current this distance. The formula for finding the size of wire is:—

$$d^2 = \frac{10.8LI}{e}$$

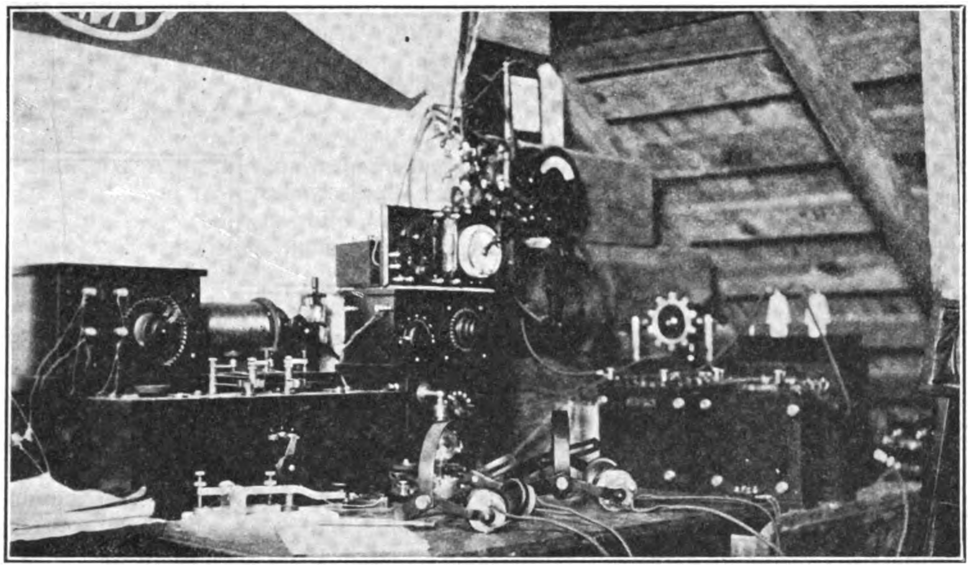
and for finding the drop in volts is:

$$e = \frac{10.8\,L\,I}{d^2}$$

in which d^2 is the area of wire in circular mils, 10.8 is a constant, "L" is the length of circuit in feet, "I" is the current in amperes, and "e" is the drop in volts.

We have, for example, a transform-

Station of the Crescent Bay Radio Association at Santa Monica, Cal., where consideration has been given to fire regulations



This station located near the Mexican border and belonging to D. H. Graham of House, Texas, could probably be improved by a more rigid observance of fire rules

er rated at 1 kw. located on the second floor of the house, and the meter is in the basement. First determine the path your wires will follow between the two points, then determine the length of wire necessary to follow this path one way. Let us say this is 75 feet. This sum doubled is substituted for "L" in the formula. Assuming that the current drawn by the transformer when operated at maximum load is about 10.5 amperes and that we have a rotary gap motor which takes 1.5 amperes, then the total load will be 12 amperes and this is substituted for "I." Now we must determine the permissible drop in potential for the value "e." The voltage at meter terminals is usually about 115 volts, sometimes a few volts higher or lower. As it is very desirable to have the voltage at the transformer terminals as high as possible, only a very small drop should be tolerated, not more than 2 volts at any rate. Suppose we use 2 volts for the value of "e." Substituting these values and solving we have $d^2 = \frac{10.8 \times 150 \times 12}{2}$ or $d^2 = 9.720$ circular mils. Referring to a table of wire dimensions we find that the size of wire which most nearly approaches our result is No. 10, and this should be used. Although this would satisfy conditions, it would be still better to keep the drop down to about 1 volt, and use a larger size of wire.

If it is desired to determine the drop in potential in an existing circuit the second formula may be used. A partial table of wire sizes covering those that are most likely to be used by the experimenter, together with those rules of the Fire Underwriters' from the 1919 code, class E, section 86, that deal with wireless telegraph apparatus, will be found at the end of this article.

In regard to the actual work of installing the feed lines; if you live in a town where it is necessary to have all electrical work done by licensed contractors, or if you do not feel capable of doing the work properly, it is best to have it done by an experienced wireman according to your specifications. If flexible armored cable is employed to protect the wires, it will conform to the Underwriters' rules and will be found very easy to install. It can be run either exposed or concealed under the floor and in partitions. The only thing that requires care is in stripping the armor to make connections, this being done by nicking it with a hack saw and bending back and forth until it breaks; then it can be slipped off. It is necessary to be very careful so that the wires or insulation will not be damaged. A condulet or other end fitting will be necessary at each end of the cable. Any wire supply store will gladly show you how to strip the cable and attach the fittings. The fuse block should be an ordinary two wire branch block for screw fuses, costing only a few cents. The new feeders should be tapped directly onto the wires from the meter that connect to the other fuse blocks for house lighting. While doing this the main switch should be opened so that these wires will be dead. All connections should be well soldered and taped. A ground wire of any kind of insulated wire of a size equal to that in the cable should be connected to the steel armor of the cable and then connected to a water pipe or other good ground. If these directions are closely followed, the radio experimenter of average ability should have no trouble in making a satisfactory installation, but he should make doubly sure that everything is O.K. by having an experienced man go over his work.

One other thing requiring attention is the provision of means to protect the house wiring from high potential surges or "kick back" from the transformer. There are a good many types of kick-back preventers; the electrolytic, needle gap, high resistance shunt of graphite rods, or large capacity condensers, etc. Probably the two best methods are the shunt condensers or the shunt resistance rods. Although the Underwriters' rules specify the condenser type of protection the high resistance shunt is used in commercial installations and is entirely satisfactory. In a future issue a full description will be given of a combined "kick-back" preventer and switch panel for experimental radio stations that is very neat and convenient and also not very difficult to construct. There are several types of this device on the market if one desires to purchase, instead of constructing it.

"Abstract from Regulations of the National Board of Fire Underwriters, Class E, Section 86, Wireless Telegraph Apparatus."

Note.—These rules do not apply to wireless telegraph apparatus installed on shipboard.

In setting up wireless telegraph apparatus (so called) all wiring pertaining thereto must conform to the general requirements of this code for the class of work installed and the following additional specifications:

a. Aerial supports to be constructed and installed in a strong and durable manner, and aerial conductors, with wires leading from same to ground switch, must be supported on approved insulators, and these conductors to be kept at a distance of not less than six inches from the building, except where entering same through approved non-combustible, non-absorptive insulators.

b. Aerial conductors to be permanently and effectively grounded at all times when station is not in operation by a conductor not smaller than No. 6 B. & S. gage copper wire run in as direct a line as possible to water pipe on the street side of all connections to said water pipe within the premises, or to some other equally satisfactory earth connection or to such other ground as may be allowed by special permission in writing.

c. Or the aerial to be permanently connected at all times to earth in the manner specified above, through a short-gap lightning arrester said arrester to have a gap of not over 0.015 inch between brass or copper plates not less than 2½ inches in length parallel to the gap and 1½ inches the other way, with a thickness of not less than one-eighth inch mounted upon non-combustible, non-absorptive insulating material of such dimensions as to give ample strength. Other approved arresters of equally low resistance and equally substantial construction may be used.

d. In cases where the aerial is grounded as specified in section b, the switch employed to join the aerial to the ground connection shall not be smaller than a standard 100 ampere knife switch.

e. Where supply is obtained direct from the street service the circuit must be installed in approved metal conduits or armored cable. In order to protect the supply system from high potential surges, there must be inserted in the circuit either a transformer having a ratio which will have a potential on the secondary leads not to exceed 550 volts, or two condensers in series across the line.

f. Transformers, voltage reducers or similar devices must be of approved type.

Wires for Interiors of Buildings
(National Code Standard)

B. & S. Gauge Number	Circular Mils	—Carrying Capacity— Rubber-covered Wires Amperes	Weatherproof Wires Amperes
18	1,624	3	5
16	2,583	6	8
14	4,107	12	16
12	6,530	17	23
10	10,380	24	32
8	16,510	33	46
6	26,250	46	65
5	33,100	54	77
4	41,740	65	92

J. A. WEVER, *Maryland.*

EXPERIMENTERS' WORLD

EXPERIMENTERS are urged to submit manuscripts covering the design and construction of all types of wireless apparatus for amateur use. Such articles will receive immediate consideration and those published will be paid for at regular space rates. The scope of this department is constantly enlarging.

Technical Advice to the Experimenter

By E. T. Jones.

THE sketch, figure 1, gives the details of a mechanism for changing the secondary inductance of a receiving tuner from one tap to the next, which at the same time causes the shunt secondary variable condenser to rotate throughout its range of capacities before another secondary coil is connected into the circuit. The whole adjustment is brought about by the rotation of a single control handle. This arrangement eliminates the necessity for using both hands in changing the inductance and capacity while tuning and leaves one hand free for writing down the message.

The objects of my design are brought about by arranging the strips of brass 1, 2, 3, 4 and 5 of the end-turn switch figure 2, so that when coil No. 2 is cut in, the condenser has revolved from zero to maximum capac-

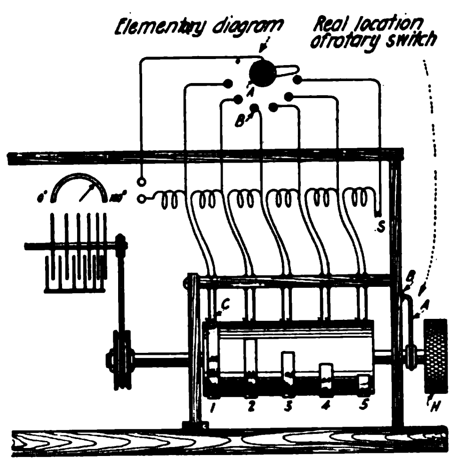


Figure 1—Detailed sketch of mechanism for changing the secondary inductance of a receiving tuner

ity, and so on throughout the series of taps. The condenser is rotated by attaching a pulley to the shaft of the end-turn switch and a smaller pulley on the shaft of the condenser. By a partial turn of the control handle the secondary variable condenser is shifted through its entire scale. It is clear to the reader that a certain relation must exist between the diameter of the pulley on the condenser and that on the main shaft; also the taps on the secondary inductance must be of sufficient width to permit the variable condenser to rotate over its scale before the switch reaches the next contact point.

The switch A, B, is of the rotary type and connects each coil in the circuit only when the last end is brought into the circuit by the end-

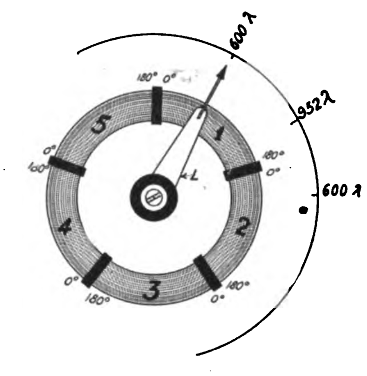


Figure 2—Rotary switch used to connect the coils

turn switch. The rotary type of switch is necessary because the contact must be maintained while the switch is rotating and it should only make connection with the next strip in the circle when additional inductance is desired.

In figure 1 the location of the switch is indicated at the lower right hand part of the drawing and an elementary diagram of connections at the upper part showing how the coils are connected in the circuit.

The rotary switch to be used in conjunction with this aparatus is shown in figure 2 where a contact lever coil makes connection with copper segments 1, 2, 3, 4 and 5. These may be made of brass if desired.

The diameter of the switch must be chosen so that an individual segment will be long enough to permit the

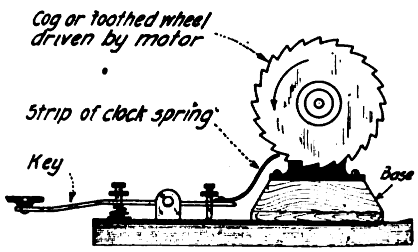


Figure 3—Mechanical code practice device

variable condenser to be rotated over its scale while the blade is on one tap.

The experimenter will observe that as the inductance switch leaves one tap and makes connection with the second tap, the wave length at the first part of the scale of the second tap will be shorter than the maximum wave length of the preceding tap. But as the switch is moved on and the variable condenser is rotated over the scale, the longest wave will be considerably in excess of the wave obtained from the preceding coil.

As indicated in the drawing a wave length scale may be attached to the inductance switch, to indicate the wave length of the secondary circuit for various positions of the shunt variable condenser.

Code Practice Device

A very serviceable set for use in code practice is shown in figure 3. The object of it is to generate a buzzing signal without the use of a buzzer.

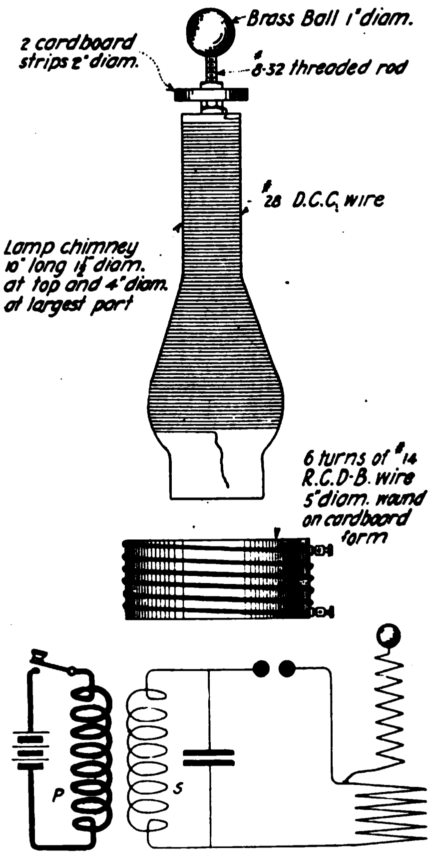


Figure 4—Diagram of detailed construction of the Oudin resonator

The telephone current is interrupted by a cog wheel which may be taken from an old clock.

No current is utilized other than that which turns the motor to which is attached a toothed or cogged wheel. The key is situated so that upon press-

ing same it raises a strip of clock spring which barely touches the revolving cog wheel. This produces a very clear note when adjusted correctly. The motor should rotate away from the operator to protect his eyes from the flying filings which are liable to be thrown from the steel spring or the brass or iron cog wheel.

A very precise adjustment can be arrived at by making tight all screws on the key after adjustment, the

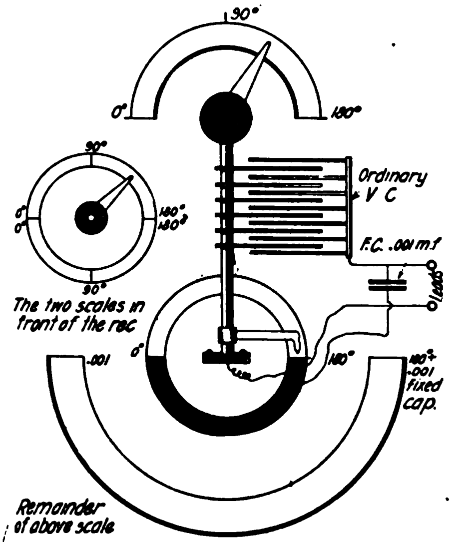


Figure 5—Sketch of a fixed condenser and variable condenser combined by means of a special switch to double the capacity

spring being arranged to barely touch the wheel in order to preserve its life. This, as a whole makes a very cheap practice set giving loud signals. A small Ajax motor and a cog wheel 4 inches in diameter by 1/8 inch thick, connected in series with four good dry cells, gives good results.

A pulsating note of a frequency depending upon the number of teeth on the wheel and the speed at which it rotates is obtained.

A Small Oudin Resonator

The Oudin resonator in figure 4 will give a good three inch spark with a 1/2 to 3/4 inch spark coil.

The secondary circuit is wound on a lamp chimney, making an excellent insulator. To place the wire, start from the end with the smallest diameter and wind upwards. It is impossible to wind from the other end owing to the slope of the chimney, but it is an easy matter to wind the opposite way. A globe ten inches long is covered with No. 28 D.C.C. wire closely wound (not spaced) 1/2 inch from the top and 2 1/2 inches from the bottom as shown. The primary is composed of 6 turns of No. 14 R.C.D. B. copper wire spaced about 1/2 inch apart, wound on a cardboard form 5 inches in diameter. The connections are shown just below the constructional drawing. This type of resonator will be found to be of exceptional interest and can be constructed at a small initial expense.

All kinds of high frequency phenomena can be demonstrated such as drawing sparks to your hand or to an iron instrument in your hand. Standing on an insulated form, matches can be lit from any part of your body by some one standing on the ground. Drop a piece of tinfoil inside the globe and a great quantity of ozone, a great germ killer and sure cure for colds, etc., will be generated and can be inhaled from the top of the globe.

Stand another small coil such as the primary or secondary of a "loose coupler" about 6 inches away from the resonator when in operation and without any connection whatsoever, a spark will appear at both ends of the winding, the forerunner of the wireless transmission of power. Hang a small light or lamp into the globe and a beautiful blue light will fill the globe. By bringing a piece of glass say 1/8 inch thick close to the ball and a piece of wire held in the hand close to the other side, the current will jump from the ball to the wire as if the glass were not there. The field for experimenting is great, and it is my personal opinion that if it ever becomes possible to intercept such waves that the whole world could be communicated with by the use of a small oudin coil. The frequency of the currents being generated are so great that they are absolutely inaudible—but who can tell what will take place in this wonderful new field in a space of ten years.

Means for Doubling the Capacity of a Variable Condenser

The combination of a fixed condenser, a variable condenser, and special switch, as in figure 5 will double its range of capacity.

It is clear from the diagram that when the ordinary condenser is at 180 degrees the maximum amount of capacity is in use, but if the condenser is brought back to zero and rotated toward the left instead of toward the right, a fixed condenser having the same amount of capacity as the variable condenser at maximum is connected in parallel. Therefore by

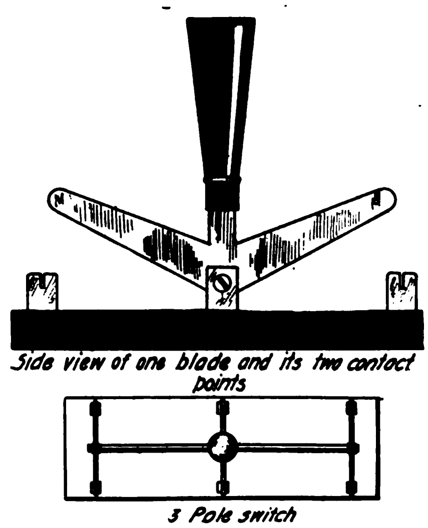


Figure 6—Sketch of switch used for starting small A. C. motors

rotating the condenser in the opposite direction, we can progressively double its capacity in the same manner as it is built up to its maximum capacity in the ordinary way. The scale on the outside of the condenser will be a complete circle instead of the usual half circle, or 180 degrees. An insulated circle is provided and half of it is made conductive by means of a strip of brass which cuts in the other fixed condenser. A switch arm protrudes from the shaft of the condenser and makes contact with the switch (brass semi-circle) cutting in the extra capacity.

This is a very convenient arrangement and is easily added to the ordinary receiver.

Special Switch for Starting Small A. C. Motors

Ordinary types of switches furnished for this purpose are of the three pole double throw type, reactance coils being thrown in on one side in the motor line circuit and the other side cutting in the full line voltage. This is an awkward arrangement owing to the fact that one is liable to throw his arm across the line when pulling the switch from one position to the other in a hurry. For that reason, I have constructed the switch shown in figure 6. It works on the rocking principle, passing through an arc of about 25 degrees, thereby making it much easier to shift the connections.

The Vacuum Tube Generator for the Radio Laboratory

A VACUUM VALVE connected up as a high frequency generator and mounted with auxiliary instruments will be found a very useful piece of apparatus around an experimental radio laboratory. It may be employed in several ways such as calibrating wave meters, inductances, condensers, measuring the decrement of decremeters and high frequency resistance; also as a source of radio frequency oscillations for beat reception and in many other ways.

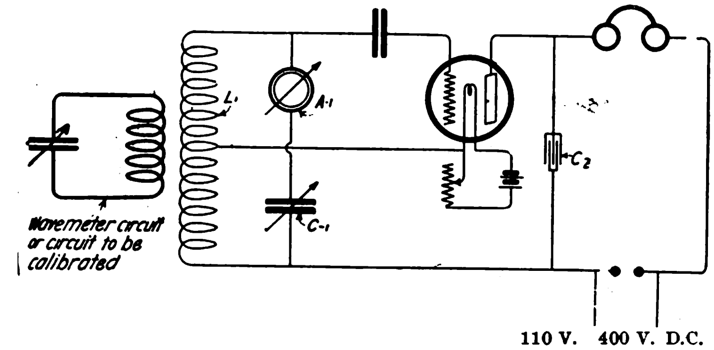


Figure 1—A simple circuit having a vacuum valve connected up as a high frequency generator

The amount of energy obtained from such a device will, of course, depend upon the size of the valve, its operating characteristics, and upon the E. M. F. of the plate battery. One hundred and ten to 250 volts D. C. can be safely applied to most bulbs, and in some cases more, without undue heating of the grid and plate, but it is best to consult the manufacturer of the tube for potentials above 250 volts.

Several circuits may be employed. That shown in figure 1 is very simple and will do the work of more complicated connections.

The size of the coil L_1 and condenser C_1 will depend upon the range of frequencies desired. It will be found that if a variable condenser C_1 having a maximum capacity of .0005 mfd. is used, the coil described below will be correct for a frequency of 120,000 cycles or above, which corresponds to the wave length of 2,500 meters at the maximum value. The coil should consist of a single layer of No. 26 S. C. C. wire wound on a tube 4 inches in diameter and 4 inches long. One hundred and seventy-five turns will be necessary, which will occupy a winding length of 3.5 inches. With a condenser C, having a capacity .005 mfd., 50 turns of the same wire, on the same sized cylinder with a winding length one inch long are needed. Three taps should be brought out from the coil, one at each end and one in the center.

The circuit should be calibrated against a standard wave meter. The distributed capacity of the coil, the effect of the leads and of the internal capacity of the bulb itself will change any theoretical determinations of the oscillation constant. A hot wire ammeter A_1 will indicate when the tube is oscillating properly. It should have a range of not over .5 amperes maximum except when large bulbs and high voltages are used. The condenser C_2 should have a capacity of 2 mfd. The telephone receivers and the grid condenser should both have a short circuiting switch or plug to cut them out of the circuit when they are not in use.

The whole apparatus should be mounted on one base or in a case with the inductance L_1 in such a position that it may be readily placed near another circuit.

To calibrate a wave meter with this apparatus place the inductance coil of the wave meter to be tested near the coil L_1 as indicated in the diagram, and set the condenser of this wave meter at some desired point. Note the reading of the ammeter A_1 in the oscillating circuit. By varying the condenser C-1 it will be found that as the condition of resonance between the two circuits is reached the current indicated by A_1 will fall off, often dropping to zero if the coupling between the two circuits is close. When the resonance point is passed the ammeter will again read the normal value. It is necessary to note the point on the condenser C_1 when the current in A_1 is at a minimum, and refer to the calibration curve for the circuit L_1, C_1 to find the wave length at this point. It is not necessary to have the two circuits coupled so tightly that the current in A_1, drops to zero, as a slight decrease is all that is necessary. Otherwise two waves will be in evidence if the coupling is too tight.

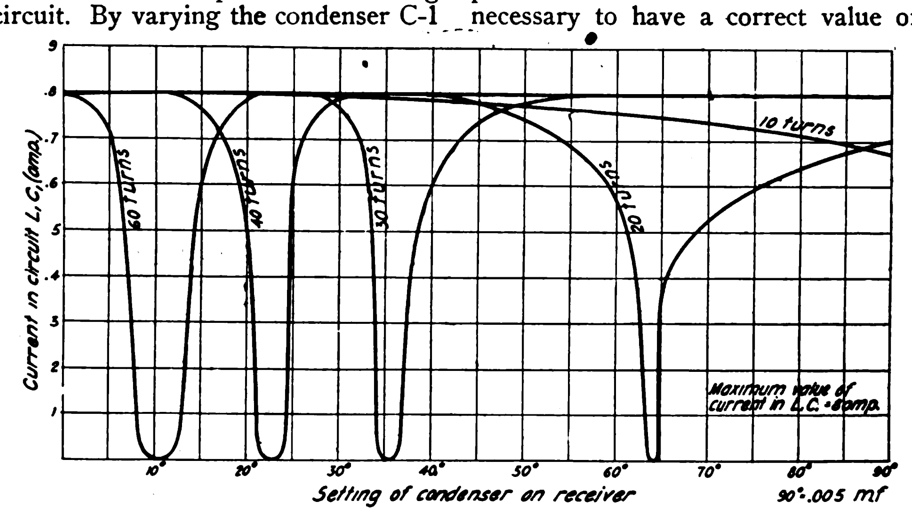


Figure 2—Graphic curves taken while calibrating a receiving set

The advantage of this method is that no connections need be made to the wave meter under test. It is a very rapid method of making a calibration. It is understood that with the standard condensers and inductances on hand the calibration of coils and condensers may be done in the same manner.

Curves taken while calibrating a receiving set are shown in figure 2. These show distinctly how the energy is "drained" from the valve circuit when resonance between the two circuits is reached. In these determinations the frequency of L_1C_1 was left constant and the condenser of the receiving set was varied, its values forming the abscissa on the curve sheet. Each curve represents one value of inductance on the receiving transformer.

There is another method in which a very interesting phenomena is made use of. It will be found that under certain conditions that a beat note will be heard in the telephones when the circuit L_1C_1 is nearly in resonance with the wave meter circuit. A shrill note is first heard as C_1 is rotated which drops to a low tone and then rises to inaudibility as the resonance point is passed. Anyone who is acquainted with beats will easily recognize the point when resonance occurs. It is necessary to have a correct value of the grid condenser, and sometimes a grid leak in order to have this action occur. An explanation of the theory of this action will be found in an article by Prof. L. A. Hazeltine, in the Proceedings of the Institute of Radio Engineers for April, 1918, on page 76.

The telephone receivers and the grid condenser are not needed for other tests and may be omitted, if desired.

RALPH R. BATCHER, *New York.*

A Small Radiophone Transmitter for the Amateur Station

LOW powered radio telephone transmitters soon will be the order of the day, but few amateurs know just exactly how to get started in this branch of radio. The books "Radio Telephony" by Goldsmith and "Vacuum Tubes in Wireless Communication" by Bucher, are excellent for obtaining an understanding of the operating characteristics of continuous wave generators for speech transmission. This article aims only to give constructional details.

Directions for assembling a small radio telephone, which should have a transmitting range of at least six miles, follow. Prior to the war, a similar but cruder set was constructed, using but one ordinary vacuum tube with a speaking range of three miles.

In constructing a radio telephone, there are three primary obstacles which confront the experimenter. He must find:

(1) A very simple and easily understood hookup, containing inexpensive and easily procured instruments.

(2) A source of direct current of fairly high voltage.

(3.) A continuous wave generator.

The three element vacuum tube will be the only type considered. Figure 1 gives a hook-up which seems an adequate answer to problem (1).

If the amateur has access to a source of 110 volt AC and a sufficient amount of money to expend, he may either obtain a 500 volt DC motor generator or a Kenotron rectifier, patterned after the Fleming valve, and obtainable from the General Electric Company. Either the DC generator or the Kenotron with 500 volts AC, may be employed to supply the plate current. With such sources of current, quite a respectable transmitting range may be obtained. However, few amateurs will care to begin their radiophone experiments on such a large scale. The experimental set herein described uses from fifty to ninety volts of the large size tubular flashlight batteries or No. 6 dry cells. In wholesale lots the price is not as high as one might imagine from retail comparison. Under favorable circumstances a discount as high as 50 per cent may be had on quantity lots.

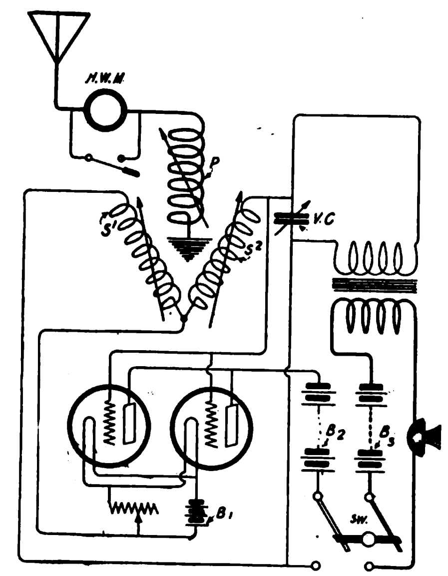


Figure 1—Hook-up of instruments for a small amateur radiophone transmitter

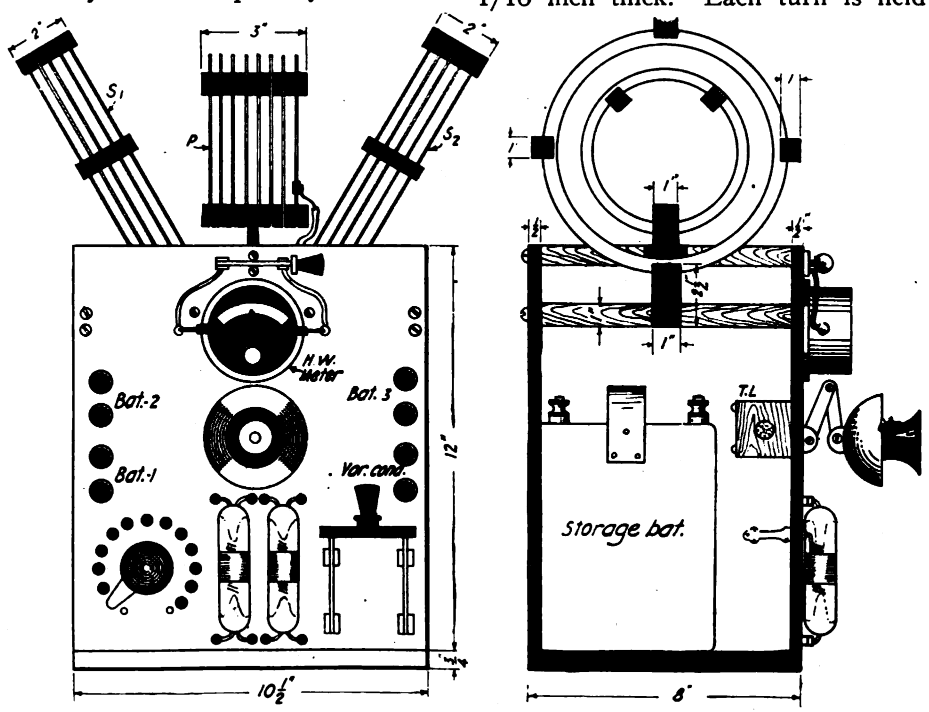


Figure 2—Front and side view of assembled radiophone transmitter

Problem 3 as in problem 2 resolves itself into a question of financial resources. The continuous wave generator in the outfit described here consists of two small, three element vacuum tubes such as tubular bulbs or electron relays with the members connected in parallel. Additional bulbs may be added to increase the range, which should be from two to six miles per bulb, depending on the tuning of the circuit and the efficiency of the antenna and ground.

After the experimenter has gained a working knowledge of radio telephony and has access to a source of high voltage, he should get possession of a "power bulb" such as the Pliotron or one of the Marconi bulbs. Large bulbs of this type, fed by 500 volts DC often given a speaking range of a hundred miles or more.

Figure 2 gives the front and side view of the assembled outfit. The front panel should be made of some good insulating material such as Bakelite. The base and back may be of hard wood treated with asphaltum varnish or a mixture of lamp-black and shellac as they are touched by no current carrying connections. On each side of the panel, about 9 inches up from base, two wooden strips 7 inches long should be placed between the back and front, to strengthen the construction. These are not shown in the side view as they would cover up the wooden, inch square strips which support the two secondaries. These hinge from the primary with these strips as axes.

Each of the two secondaries, S_1 and S_2, is composed of five turns of edgewise wound copper strip spiral 7½ inches in diameter, ½ inch wide and 1/16 inch thick. Each turn is held ⅜ inch apart from the adjoining turn by strips of Bakelite, 1 inch square and 2 inches long, except at the bottom. The coil is fastened to the axis upon which the secondary pivots by a piece of Bakelite shaped as in figure 3-A. The primary, P, is composed of copper, spiral wound edgewise as the secondaries and is 5 inches in diameter, 5/16 inch wide and 1/16 inch thick. Each adjoining turn is held ⅜ inch apart by Bakelite strips, ¾ inch square and 5 inches long, except at the bottom, where the primary is supported by a piece of Bakelite as in figure 3-B. This piece is to be fastened to a strip of wood, held between the front and back panels by wood-screws as in the side view of figure 2. The copper strip for the "oscillation transformer" may be purchased from wireless supply houses.

The transformer is designed considerably heavier than necessary for the current derived from the high voltage battery as suggested here, for the experimenter sooner or later may find himself in a position to use power bulbs and a commercial form of high voltage supply.

In most radiophone circuits a radiation indicator (such as a hot-wire ammeter) is essential, for successful operation depends mainly on careful tun-

ing. The meter suggested is one of the small "junior" patterns. It should be short circuited by the switch at top of panel when not in use.

The battery B_3 in the transmitter circuit may be from six to ten volts of storage or No. 6 dry cells. The transmitter is taken from one of the common long-distance telephones. If it happens that the carbon grains become fused, replace them with larger grains. The induction coil I is nothing more than the ordinary telephone

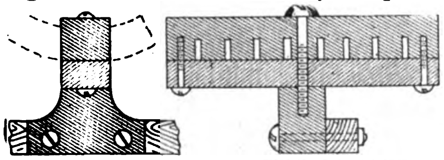


Figure 3A—Detail of fastening coils

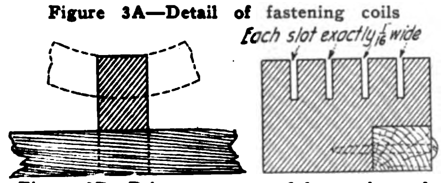


Figure 3B—Primary supported by a piece of Bakelite

transformer. A type that will operate from a ten volt dry battery may be purchased from any electrical supply house. Both the high voltage battery B_2 and battery B_3 are cut into the circuit by the switch at the bottom of the panel. One rated at 30 amperes, 250 volts is about the right size to use.

Battery B_1 is a six volt storage battery and is mounted behind the panel to prevent the outfit from overturning. The filament rheostat in the lower left hand corner of the panel is made in accordance with my article in the November 1918 Wireless Age. There are sixteen points of variation of one-half ohm each. A good radius for the switch points is 1½ inches.

Better results will be obtained if the bulbs are purchased from a reliable company which standardizes its products, that is, all bulbs are supposed to be alike.

The variable condenser VC is one of the 43 plate receiving type, filled with castor oil, or a good grade of motor oil to give a capacity of .005 mfd.

The design of the three coupling coils herein described permits a range of 180 to 350 meters with the average antenna. If permission can be obtained to use a longer wave length, either a loading coil or a longer aerial may be used, of which, the latter is preferable.

The variation for the high voltage battery is obtained by a clip and flexible lead at the battery box as it would be impractical to take a large number of leads up to the panel from the batteries.

It is of even more importance in radio telephony than in wireless telegraphy that the various leads and connections should be of litzendraht or stranded wire, and well soldered. No. 12 rubber covered stranded wire, is a practical size for the outfit described.

It would be a great benefit to experimenters if some genius for organizing would start a "National Amateur Radiophone Service League," modeled on the same general plan as some of our present relay organizations.

Think it over fellows, and send in your suggestions to The Wireless Age.

Francis R. Pray—*Mass.*

Design of a Self-Cooled, Quenched Spark Gap

Assume that the amateur desires to construct a quenched spark set to fit a 1 kw. 500 cycle transmitting set, so that the gap will be self-cooling. Also assume an 11,300 volt transformer and a condenser capacity of .008

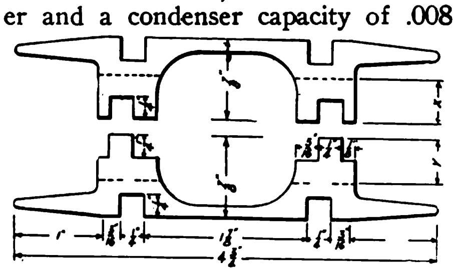


Figure 1—Showing design of spark gap

mfd., experience teaches that the gap current will be about 18 amperes. This is the root mean square and must be mutiplied by $\sqrt{2}$ or 1.4 to obtain the maximum value, namely 18x1.4=25.2 amperes. In the design of quenched spark gaps, one square inch of surface should be allowed for every 10 amperes of current. Gaps of smaller dimensions will cause arcing, and plates of excessive size will cause a ragged spark tone.

In the particular example cited, 25÷10 gives 2.5 square inches as the area of the gap, keeping in mind that diameter $= \sqrt{\dfrac{\text{area}}{.7854}}$; and in this example $\sqrt{\dfrac{2.5}{.7854}} = 1.8$ inches approximately. We must now allow 10 mils separation between the plates and a potential difference of 1,000 volts per gap; also we must allow .25 inches between the silver and the rim. If the rim is 3/16 of an inch in width, the total area of the rim will be approximately 1.4 square inches. We may now allow for the gap losses, 15 per cent. of the power, which in this case equals 150 watts; and since for a potential difference of 1,000 volts we must have 11 gaps, we must allow 150÷11=13.6 watts to be dissipated per gap. Then assuming .2 watts per square inch for a 50° C. rise of temperature for continuous working, we have 13.6÷.2=68 square inches, the surface required.

If we employ 2 cooling vanes per gap, then the approximate area will be equal to 68÷4 (the number of sides of two vanes)=17. The over-all diameter $= \sqrt{\dfrac{17}{.7854}} = 4.7$.

It is now assumed that the completed gap is mounted in a metal

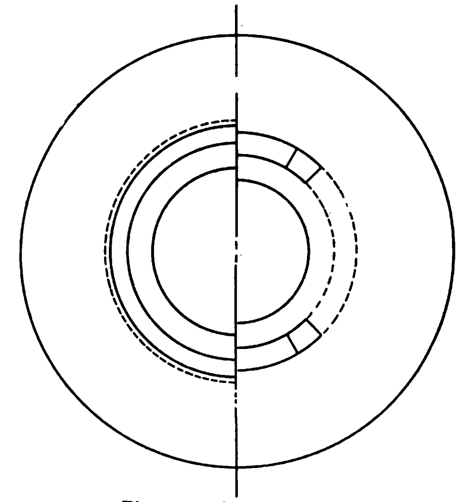


Figure 2—Gasket plates

frame and that the plates are pressed tightly together by means of a threaded bolt. We may then determine the leverage ratio with a 13 thread screw bolt and a 6 inch wrench; that is, ratio $= 2\pi$ 6x13 threads x 1 lb. = 489.84, or approximately 490. If we allow 150 lbs. per square inch to make up for the tightness required with mica gaskets, we have 150x1.4 (area of rim)=210 lbs. Figuring $\dfrac{210}{490}$ gives about ½ lb. pressure to be placed on the end of a 6 inch wrench.

The sections marked X and Y of figure 1 are cut away to a depth of ½ inch for a space slightly less than ¼ circumference of the circle, so that

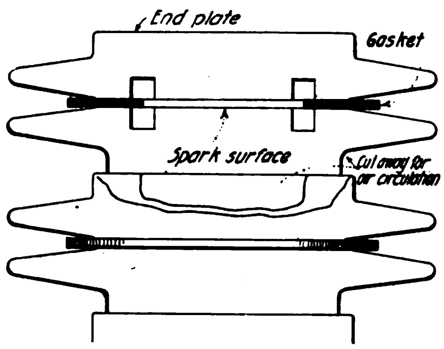


Figure 3—Spark surface of plate

when the gaps are put together the air can circulate through the main body of the gap.

Figure 2 shows the plates of the gasket and figure 3 the sparking surface of a particular plate. It also shows a portion cut away for air circulation. If the gap is to be used intermittently, allow .4 watt cooling surface for a 50°C. rise in temperature.

J. J. Holahan, *Virginia.*

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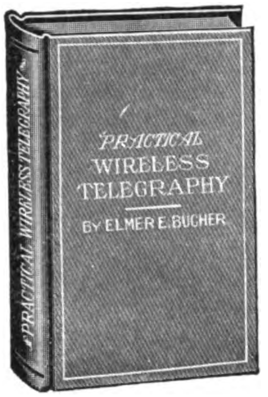

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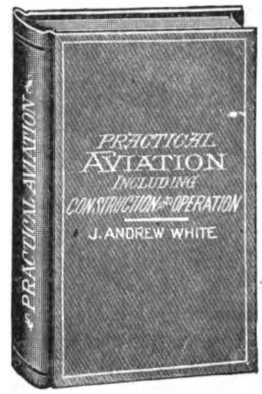

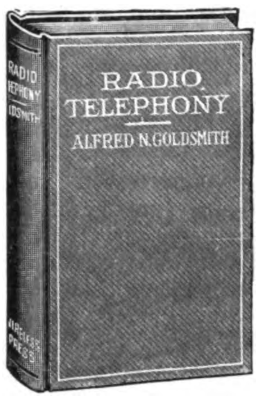

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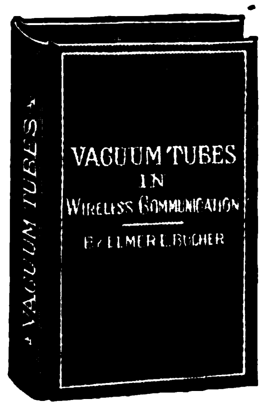

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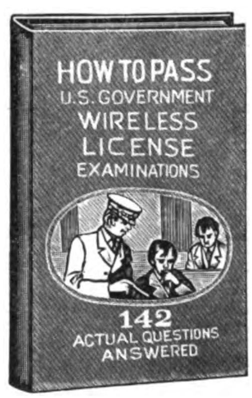

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Finding the Distance Between Wireless Stations

THERE is only one practical method of accurately finding the distance between any two points on the earth's surface, such as two wireless stations, and that is by means of spherical trigonometry. Recourse is had to this method in navigation, astronomy, and other scientific pursuits; also, maps are plotted from certain calculations obtained in this way. All maps based on Mercator's projection become increasingly inaccurate as the poles are approached, and hence are of no value in finding distances near the poles, or those which span any great part of the earth's circumference.

The actual details connected with the method herein described are usually taught in advanced trigonometry classes in colleges, but since only a few formulas are needed, along with a table of the various trigonometric functions, it is presented in the hope that those who have not had the advantage of such training, or else have forgotten the work, may avail themselves of the method. The use of the tables does not necessarily require a knowledge of trigonometry, but a working knowledge of common logarithms will greatly simplify the labor incident to these calculations.

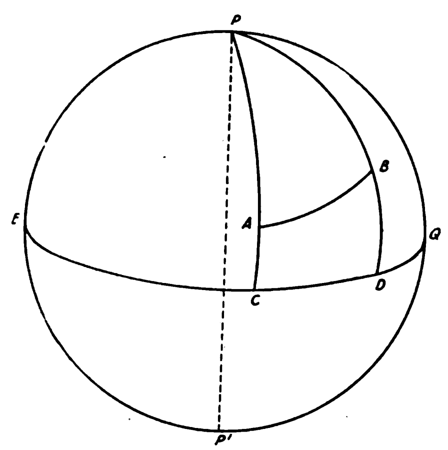


Figure 1—Diagram showing method of determining the distance between two wireless stations

The tables should give the values of the sine, cosine, tangent, and cotangent to within 10′. Greater accuracy is not required, as it is usually impossible to obtain the latitude and longitude with much more exactitude than this, and since 1′ is only equal to 1.1516 miles, the error is inappreciable.

To apply this method, it is only necessary to know the latitude and longitude of each of the two places concerned, which can be found on any map, and by use of the formulas which will follow, the distance between them can readily be found. A brief discussion, however, will be of value to anyone making use of these formulas. In figure 1 is depicted the earth's globe, P and P′ representing the poles, EQ the equator, and A and B any two points on the earth's surface whose separation it is desired to find. It is evident that AC is the latitude of A, BD the latitude of B. By substracting each of these values from 90 degrees we will obtain AP and BP respectively, the two known sides of the spherical triangle ABP. It is to be noted that these values are in degrees and minutes, as in the case of spherical triangles the sides are given as parts of an arc or a circumference.

Also, A has a given longitude, and B has a given longitude, and the difference between these two values will be the separation of A and B in degrees of longitude along the equator, or, the value of the angle APB. In case either A or B are on opposite sides of the prime meridian, or of the 180th meridian, a different procedure must be followed, as is explained later.

We have now determined the two sides AP and BP, and the included angle APB, of the spherical triangle ABP. For the sake of convenience, we shall refer to the angles shown by the capital letters which designate those extremities, as angles A, B and P. The sides of the triangle shall be referred to as AP, BP, and AB, the latter being the unknown side whose length we are to find.

The following formulas are then applicable, the first two being Napier's Analogies:

$$\text{Tangent } \tfrac{1}{2}(A+B) = \frac{\cos \tfrac{1}{2}(BP-AP)}{\cos \tfrac{1}{2}(BP+AP)} \cot \tfrac{1}{2} P$$

$$\text{Tangent } \tfrac{1}{2}(A-B) = \frac{\sin \tfrac{1}{2}(BP-AP)}{\sin \tfrac{1}{2}(BP+AP)} \cot \tfrac{1}{2} P$$

Also, $\tan \frac{1}{2}(A+B) + \tan \frac{1}{2}(A-B)$ = greater unknown angle, and $\tan \frac{1}{2}(A+B) - \tan \frac{1}{2}(A-B)$ = smaller unknown angle. Which angle is A and which is B can be found by applying the rule from geometry, that the greater angle is opposite the greater side, and vice versa.

Having found the unknown angles A and B of our triangle, we now apply the law of Sines in spherical triangles, namely:

$$\sin AB = \frac{\sin P}{\sin B} \sin AP$$

Looking up the value for the anti-sine of AB, gives the distance between these two points in degrees and minutes. This value (in degrees and decimals of a degree) is then multiplied by 69.117 to obtain the distance in statute miles.

Let us now examine the results of an actual calculation to fully fix in our mind the use of these formulas. Supposing it is desired to find the distance from Arlington, Va., to Kahuku, Hawaii. The latitude and longitude of the former are 38° 50′ N., 77° W., respectively; of the latter, 21° 40′ N., 158° W. Subtracting the two latitudes from 90°, we have 51° 10′, and 68° 20′ for the sides BP and AP of the triangle, respectively. Also, the angle P, being equal to the difference in longitude of the two places, is 158° — 77° = 81°. Applying the formulas:

$$\tan \tfrac{1}{2}(A+B) = \frac{\cos \tfrac{1}{2}\ 17^\circ\ 10'}{\cos \tfrac{1}{2}\ 119^\circ\ 30'}\ \cot \tfrac{1}{2}\ 81^\circ = 2.298$$

$$\tan \tfrac{1}{2}(A-B) = \frac{\sin \tfrac{1}{2}\ 17^\circ\ 10'}{\sin \tfrac{1}{2}\ 119^\circ\ 30'}\ \cot \tfrac{1}{2}\ 81^\circ = 0.2023$$

Looking up these values, we have, $\tan \frac{1}{2}(A+B) = \tan 66^\circ\ 30'$, and $\tan \frac{1}{2}(A-B) = \tan 11^\circ\ 26'$. Therefore, applying our rule for finding the unknown angles, and noting that the angle at Arlington is the larger of the two, we have:

$$\text{Angle } A = 66^\circ\ 30' - 11^\circ\ 26' = 55^\circ\ 4'$$

and

$$\text{angle } B = 66^\circ\ 30' + 11^\circ\ 26' = 77^\circ\ 56'$$

Also, we have

$$\sin AB = \frac{\sin 81^\circ}{\sin 77^\circ\ 56'}\ \sin 68^\circ\ 20' = 0.9386$$

From which AB = 69° 50′, or 69.8°. This is then multiplied by 69.117, giving the value 4825 statute miles as the distance between Arlington and Kahuku.

It has been stated that in case the stations are located on opposite sides of the prime meridian, or of the 180th meridian, a different procedure is necessary for finding the angle P. In the first case just mentioned, the longitudes are added instead of substracted, in the second case both values are subtracted from 180° and the results added together. A little consideration will show the necessity of such methods.

In case the two points are almost of the same latitude, a simpler method will give the same results. It consists in finding the difference in longitude of the two places, and multiplying this by the value of a degree longitude in miles, at the mean latitude. For example, Funabashi, Japan, is at latitude 35° 40′ N., and Los Angeles, California, is at latitude 34° N. The mean latitude is 34° 50′, and at this latitude a degree is equal to 56.95 miles. Hence the distance is equal to 101.67° (the difference in longitude) times 56.95 = 5790 miles. Tables of this sort are called spheroidal tables, giving the length of a degree longitude at various values of latitude, in nautical and statute miles. The student is referred to the Year Book of Wireless Telegraphy for the complete values.

Hints for the Experimenter's Workshop

YOUR readers may be interested in the method, shown in figure 1, for making rods for zinc spark gaps. An iron pipe is sawed lengthwise as in

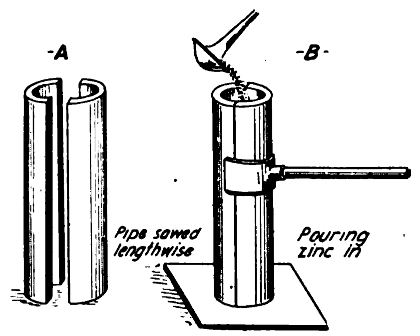
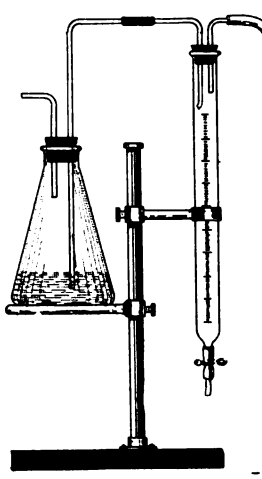


Figure 1—Showing method of constructing zinc spark gap rods

A to constitute the mould. The zinc cases of old dried batteries are melted and poured in as shown. In the same manner points for rotary gaps can be made. A threaded bolt should be moulded in place in the process so that the points can be screwed to the rotor.



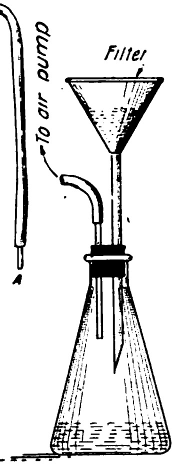


Figure 2—Design of an automatic burette

Figure 3 — Rapid filtering device

In figure 2 is shown an automatic burette that the experimenter can construct with the apparatus at hand. The liquid used in the titration, etc., is put in the flask which is connected to the burette as shown. This is brought into the burette by suction applied at the mouthpiece A. The entire apparatus and the burette is easily filled.

An apparatus for rapid filtering is shown in figure 3. It is connected to a filter pump which is easily constructed by the amateur if necessary.

CAESAR KLAUS, *Illinois*.

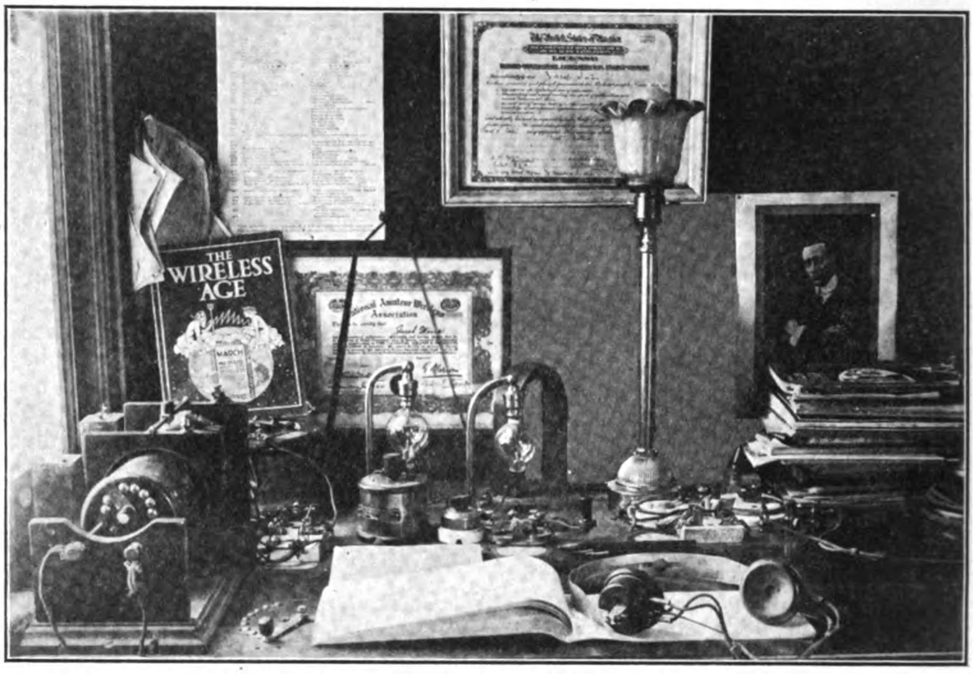
Contest Winners for the March Issue

In response to the call in the December issue for manuscripts concerning the re-opening of amateur stations, prizes have been awarded to the writers of the following articles. The suggestion upon which the contest was based was:—AT THE FINAL CONCLUSION OF PEACE NEGOTIATIONS, WHAT DO YOU CONSIDER TO BE THE MOST IMPORTANT REASONS FOR IMMEDIATE OPENING OF AMATEUR WIRELESS STATIONS?

First Prize — Why the Amateur Should Be Allowed to Resume Operations

THE chief reason why the wireless amateur should be allowed to resume, after the war, is the fact that one naturally has the right to use the ether just as one has a right to breathe the air. Recently a power greater than his own compelled the amateur to relinquish the practice of his favorite art. But this power did not and could not take away his rights; it merely forced him to abandon the practice of them for a time. The wireless amateurs do not question the wisdom of this course. What the wireless amateur objects to is not regulation but annihilation. If anything is common property, it is the air and the ether. A man has the right to all the air he can use, but he has no right to control the rest of it; likewise no man or set of men has a right to appropriate the ether to his own exclusive use. All have a right to use it provided they have a due regard for the rights of others.

If it be said that the wireless amateur might pick up secret messages, I reply that no information of a confidential nature should be sent by radio except in code. In connection with this phase of the matter it is well to remember that if one were determined to get through a message for an improper purpose, one could do so, law or no law. A man cannot be prevented from buying wire and other materials. Now, it is well known that thousands of people can make all the parts of a wireless set. So if anybody wanted to do any surreptitious receiving, he could pack his instruments and a coil of wire in a suit case, go to some secluded spot, string the wire on trees, connect it up and listen to anything within range. The reception of messages by the evil-disposed cannot be prevented. No class of people has the moral right to take permanent charge of the ether simply because they wish to send information whose publicity would injure or embarrass them.



Station of J. Weiss, Port Washington, N. Y., an excellent type of high-grade equipment, which can be put to good use as soon as Government restrictions are removed

It is true that a very few amateur sending stations did interfere with other stations prior to the war, but this can easily be prevented. Let a few of these offenders be punished and the rest will reform in haste. The government has the whole matter in their own hands. If they fully prescribe the amateur's sending outfit, they will have full and effective control of him. In order to have effective control the government should prescribe not only the transformer input and wave length, but also the length and height of the

aerial and the dimensions of the (sending) oscillation transformer. They should not allow an antenna that requires a condenser in series to be used; there would be danger that the condenser would get cut out! If fair play and good judgment rule, there is plenty of room in the surrounding ether for both the amateur and the commercial operator.

Then the more widespread the practice of the wireless art the greater will be the progress in it. The spirit of inquiry not only produces inventions but actually produces the inventor himself. He is the ultimate result of countless investigating minds.

simply do the work that comes to hand, and their sole desire is to maintain their position on the pay roll in increasing opulence. If the commercial wireless operators have no more of the spirit of inquiry than their brethren of the wires, let us thank heaven for the gift of the amateur and pray for his speedy return to the good work, for he loves the art of wireless for its own sake and is always striving to advance it.

So the matter seems to resolve itself into this: Everybody has the natural right to use the regions of space while he has a due regard for the rights of others. This being a self-evident fact,

An exhibit of the Atlanta Radio Club, indicating a high order of scientific training and practical work in the wireless field, developed by amateurs during the pre-war period

And has our government not had reason to rejoice that there was an army of wireless amateurs in the country when the war came? Suppose the amateur had never built his station or practised the art. In that case would there have been the interest in wireless when the war started that there was? Complete figures are not available, but it is certainly true that thousands of young men, on account of their previous experience as amateurs, fitted themselves in a few months for government work and rendered valiant service to the cause. Shall these young men, when they return, find that their government has condemned their former activities and forbidden their resumption.

The enthusiasm of the amateur should not be overlooked. I am not acquainted with any commercial wireless operators, but I know something about the wire telegraphers. I never knew one of them to make an effort to discover anything new in the art. They have no spirit of interest or curiosity. I have known good practical operators who could not connect up a simple set of instruments. They

we should not be required to prove it. The burden of proof is on those who think that the amateur should not invade the ether. We may well ask: What harm has the amateur done or what harm can he do under reasonable restrictions?

S. F. MCCARTNEY—*Pennsylvania.*

Second Prize — Why Stop the Growth of an Art That Improves the Man?

THE closing of the amateur wireless stations when we entered the war was a military necessity, and there is no reason why they should not be permitted to open just as soon as this military necessity ceases to exist. In fact a consideration of what amateurs have accomplished and what they may accomplish will disclose many reasons—logical ones, too—for permitting their opening just as soon as international conditions permit.

Only one objection can be raised against them and that is "interference." This is of two classes—one malicious, due to irresponsible, flighty amateurs; the other is just "interfer-

ence" due to lack of scientific knowledge. Both disturb the sincere amateur as much as the commercial or Government stations and the sincere amateur is about 90 per cent of the field.

Malicious "interference" should be and can be punished by existing statutes and the amateur should and will give his aid to bring this about.

"Interference" is a problem recognized and appreciated by all amateurs as well as by radio engineers and is now well on the way to solution.

Amateurs are studying ways and means to overcome interference as well as how to work over long distances with a minimum of energy at the sending station and a maximum at the receiving station.

Their problems are the same as those of the commercial and Government stations and instead of the solution being sought in one or two elaborately-equipped ideally-situated laboratories by an intellect skilled in research work for so much a year, the problem is being attacked by amateurs in thousands of laboratories, where each instrument is worked to its finest point and under thousands of conditions most of which are not ideal; the workers are not skilled in research work and are after immediate practical results.

Prior to the closing of the amateur radio stations their achievements in long distance transmission and receiving and continental relay work, in the better application of old principles and in the discovery of new ones, were noted almost daily. Their results are a matter of record and were gained only by hard work and sacrifice.

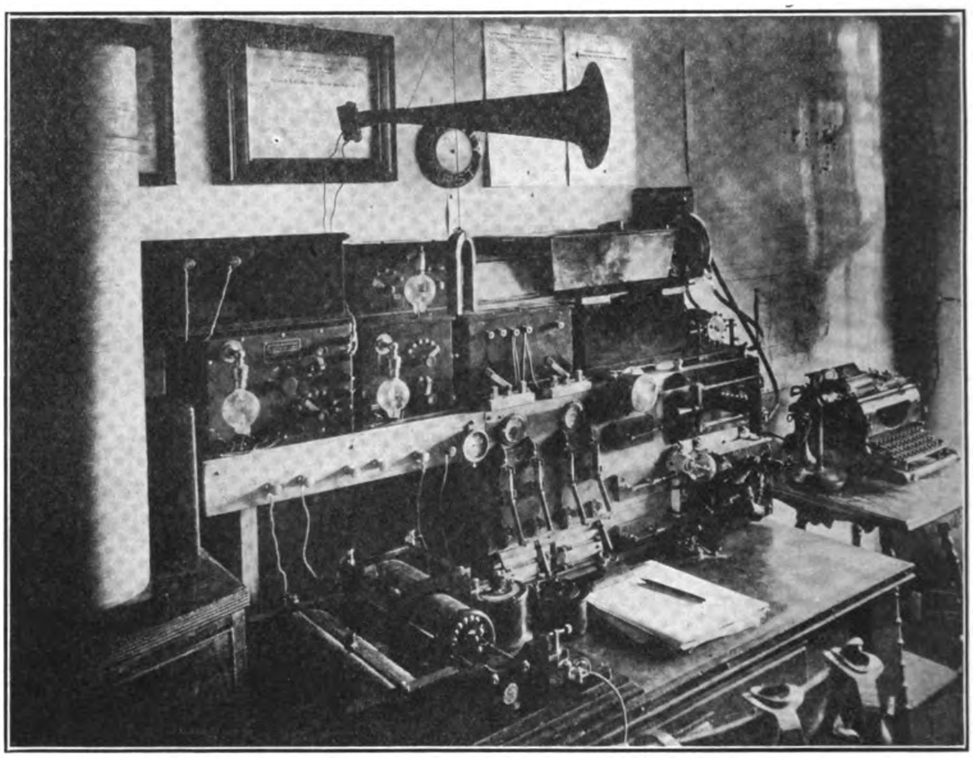
The stuff the amateurs are made of, their strength of character, their resourcefulness in an emergency and their ability to deliver the goods was proven in the conflict which has just been closed. "Sparks" as a rule braves danger and risks alone, silently and with no comeback, and not with a company of his fellows, amidst insane din and activity, as does his soldier and sailor brothers.

The foundation for this character and ability was laid years ago in an attic and in most cases under difficulties. An amateur radio operator is not an "operator" from choice but from necessity—he is not actuated by a desire to send a message but by a desire to know how and why the message can be sent at all.

This subject requires much careful investigation and thought; the application of his conclusions develops his manual dexterity. The cost of his instruments if purchased is almost prohibitive; but while they are very delicate and sensitive he may make them himself, from fairly cheap raw material and a few tools.

So we have a condition where a young, enthused mind controls its thoughts, analyzes, puts together, draws conclusions and expresses the results of those efforts in a device in which skill and care in manual effort is a great factor toward the desired result, and it is done for the sake of the work.

An amateur radio engineer is bound to be a better citizen than the average



Amateur station of Chris M. Bowman of Pennsylvania. Scientific work of this nature should be encouraged—not destroyed—by the Government

of his fellows because of this training and for this reason he should be given freedom to expand and grow, even if the advantages of the success of his efforts were not available—but they are and he is a tremendous force in the field.

Control his efforts by all means; it will help to make him a better man but no reason has yet been advanced for stopping his efforts, and there is no reason why amateur radio stations should not be permitted to open just as soon as the necessity for closing them ceases to exist. This necessity will have ceased to exist the instant after the treaty of peace has been signed.

F. L. LEMM—*New York.*

Third Prize—Shall Amateur Wireless Stations Be Re-opened?

THE end of the war has brought forth a great many problems that must be settled. One of them, and to a large number of Americans a very important one, is: Shall amateur wireless stations be re-opened at the final conclusion of peace negotiations?

A number of reasons for an affirmative answer can be pointed out.

We have just concluded, with our Allies, a war to "make the world safe for democracy." An important condition for keeping it so is a perfect understanding among the nations. This demands more reliable and better communication than we have had in the past, and here wireless telegraphy can play a role of no little importance.

As this is true of a number of nations, so it applies to a single nation. Added facilities for communication make for better union. This idea, in a large measure, was followed (in America) before we entered the war by wireless amateurs, although they perhaps did not realize it. As time went on, distant parts of the country were brought together by wireless, which brought about a general feeling of brotherhood — an indispensable factor in maintaining a democracy. This feeling of good-will and brotherhood existed invariably in a community having one or more amateur wireless stations. The permission to re-open these stations would be marked by a continuance and an increase of this good work.

In the first days of unpreparedness when our country entered the great war, and when the Army and Navy were in desperate need of young men who understood wireless telegraphy, the inherent patriotism of the amateurs was demonstrated beyond doubt. A great many volunteered, being willing to risk life and limb in the service of their country, whose free institutions permitted the operation of apparatus which had given them so much pleasure and education. And while it is not to be thought for a moment that they served for reward, it surely would be a mark of ingratitude for the Government to take from these fighters and those who helped to make it possible for them to fight, this mode of experimentation which is so beneficial and harmless when properly controlled. Such action would not be worthy of our nation.

There are instances on record of amateurs giving material aid to public officials. For example, an amateur helped prove that our neutrality was being violated by the Sayville wireless station. Once when a shore party from some Naval vessels was unable to establish communication with the ships, an amateur, upon request, did the needful thing. During the heavy floods of 1913 some communities would have been cut off from the world for days had it not been for amateur wireless stations. These instances and others prove that it would be wise to permit amateurs to continue their operations for the aid they could give in emergency or disaster.

Our rapidly growing Navy and Merchant Marine will require a large number of wireless operators. Formerly, even with the aid of the amateurs, the Government and the commercial companies could not obtain sufficient men. Now the need is greater and the difficulty will increase if there is not a large body of amateurs to draw from.

With a great many persons interested in wireless telegraphy the chances for invention and improvement are multiplied many times. Investigation and attempts at improvements are qualities characteristic of every earnest amateur. Beneficial results are bound to follow. For instance, Marconi was but a plodding, persistent amateur when he made his famous and priceless invention. Armstrong, whose amplifying circuits have done so much to extend the scope of wireless telegraphy, had scarcely attained his majority when his discovery was made. And Weagant, who was recently credited with overcoming the greatest enemy of wireless communication, began his task when but a young man. With these examples before us what may we expect in the future from amateur wireless experimenters?

All these reasons, and doubtless others exist, point to the wisdom of re-opening amateur wireless stations as soon as peace negotiations are on their way to final settlement.

ROSS MOORHEAD—*Ohio.*

Both Sides of the Government Ownership Question

(*Continued from page* 21)

the amateur arguments, which were reported in the February issue, several interesting statements were made which space does not permit dealing with here.

Captain Todd then appeared in rebuttal, arguing that the bill had nothing to do with patents or manufacturing in itself. He called for legislation which would further limit amateur operation, the concentration in one authority of coastal station operation, and issuance of licenses for all receiving stations.

Fulton Cutting, of Cutting & Washington, opposed the bill, stating that if it went through he would close out his company, not caring to be in a business where the U. S. Government would be the only customer. Lester L. Israel, radio engineer, gave reasons for his opposition that were an outspoken indictment of the showy and wasteful system in the Navy, as determined by his own experience during four years in the Navy Department. George McK. McClellan, representing the Honolulu Chamber of Commerce, said that Hawaiian business men strongly resented the Navy's bureaucratic administration and protested against the policy of the Government to continue its war control. Emil J. Simon, radio engineer, vigorously attacked the various provisions of the bill and used his own experience to demonstrate how young men could build up a substantial manufacturing business without fear of the Marconi "monopoly," which the Navy had attempted to prove practically existed.

Samuel E. Darby, patent attorney, representing the De Forest Radio Telephone & Telegraph Company, said that the company was "with the Government and in favor of the proposed bill." George S. Davis, general manager, radiotelegraph department, United Fruit Company, who preceded him, took the reverse attitude and showed by comparison that wireless was better for all concerned with the field open for all commercial interests.

The hearings closed with the introduction by Representative Lufkin of a letter of protest from an amateur of Essex, Mass.

As reported in the February issue, the committee, on January 16, by unanimous vote tabled the bill.

Queries Answered

Answers will be given in this department to questions of subscribers, covering the full range of wireless subjects, but only those which relate to the technical phases of the art and which are of general interest to readers will be published here. The subscriber's name and address must be given in all letters and only one side of the paper written on; where diagrams are necessary they must be on a separate sheet and drawn with India ink. Not more than five questions of one reader can be answered in the same issue. To receive attention these rules must be rigidly observed.

Positively no Questions Answered by Mail.

K. K. K., Elizabeth City, N. C.:

Ques. (1)—Is the regenerative beat receiver shown in figure 108 in the book "How to Conduct a Radio Club" more efficient than the modified Weagant circuit shown in figure 69 of the book "Vacuum Tubes in Wireless Communication"?

Ans. (1)—Practically identical results will be obtained from either circuit. The principle point of difference lies in the method of connecting the tuning elements of the plate circuit. In figure 108 the regenerative coupling coil is placed on the low voltage side of the secondary circuit. In figure 69, it is on the high voltage side. The circuits of figure 69 are less difficult to adjust than those in figure 108, for by proper design of the coils in figure 69 all the tuning necessary can be obtained by the loading coil L-1, secondary condenser C-1 and plate circuit condenser C-2, that is, these are the principal adjustments.

Ques. (2)—What would be the approximate range of wave lengths over which the apparatus shown in figure 108 of "How to Conduct a Radio Club," would work with coils L-3 and L-7, 20 inches in length, 6 inches in diameter, wound with No. 28 enameled wire; and if coils L-5 and L-6 were wound with No. 24 and No. 30 enameled wire respectively, the secondary coils being 7 inches in length, 4½ inches in diameter and the primary 7 inches in length, 4 inches in diameter?

Ans. (2)—The set should respond to wave lengths up to 8,000 meters and by shunting secondary L-7 with a variable condenser, still longer wave lengths may be obtained provided close coupling is employed at the coils L-2 and L-4.

* * *

H. C. K., Canton, Ohio:

Ques. (1)—In order to receive signals from both Naval and amateur stations would there be any marked advantage in erecting two separate aerials from the same support, one aerial to consist of two wires 350 feet long and the other of two wires 100 feet long? The wires in each aerial would be spaced three feet.

Ans. (1)—If the vacuum tube detector is employed in the receiver, an antenna short enough to receive amateur wave lengths would also work well on the longer wave lengths such as employed at high power stations. On the other hand, an aerial long enough for reception from high power stations would have too great a fundamental wave length for reception from amateur stations. Moreover, if separate aerials are employed, they should be placed a considerable distance apart, for otherwise, tuning on one aerial will effect the electrical constants of the other. However, this would not be so noticeable if the earth connection of one antenna is broken while the other is employed. For amateur reception a hundred foot aerial is preferable and with a good sensitive vacuum tube or a cascade tube amplifier you would obtain nearly as loud signals from high power stations on this aerial as from the longer one.

* * *

G. T. S., Chicago, Ill.:

Ques. (1)—Can I erect an aerial in my attic of a three-story building?

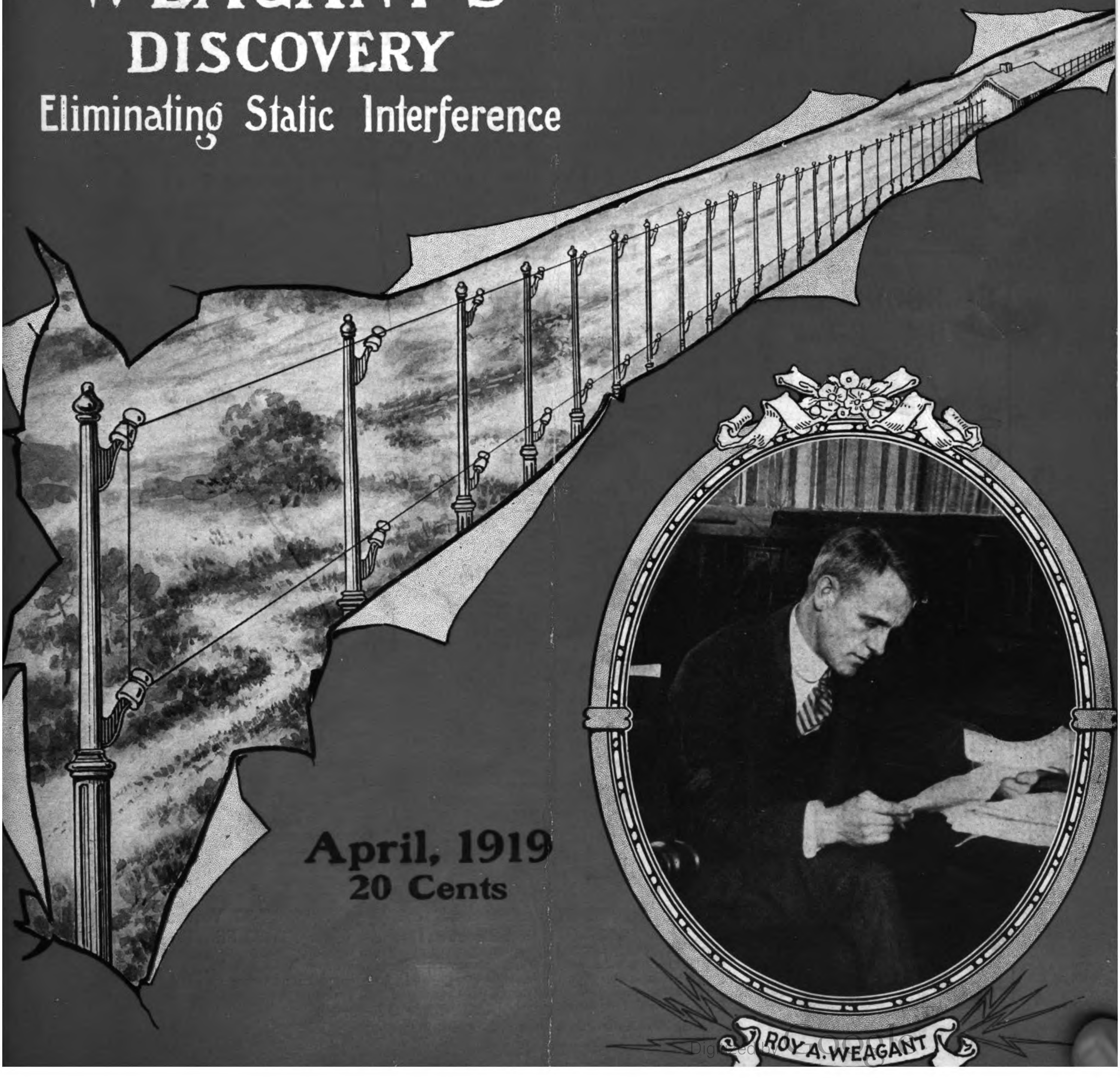
Ans. (1)—For receiving purposes it will work well, particularly if you use vacuum tube amplifiers to detect the signals. The efficiency will be somewhat lower for transmitting purposes, but fair results over short distances will be obtained.

Ques. (2)—Will lightning effect the house when the aerial is under the roof? It is my understanding that copper wire draws lightning.

Ans. (2)—The aerial would perhaps give better protection if it were outside of the roof because under the condition you mention, if the aerial was struck by lightning it would necessarily pass through the roof of your house to reach the aerial. However, it is rarely that one hears of amateur stations being struck by lightning and you therefore need have no fear on this point.

The
WIRELESS AGE
Volume 6 Number 7

WEAGANT'S DISCOVERY
Eliminating Static Interference



April, 1919
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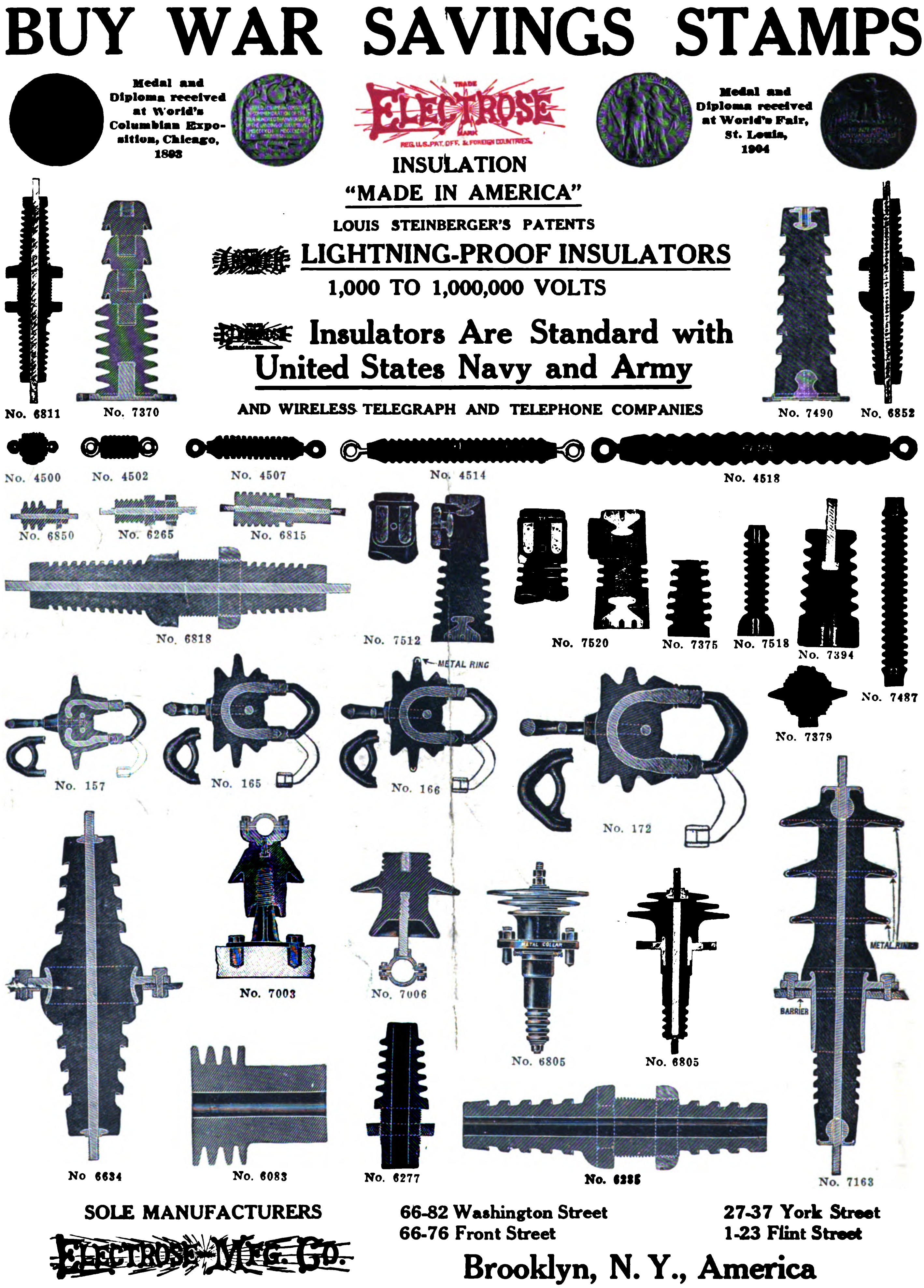
BUY WAR SAVINGS STAMPS
Medal and Diploma received at World's Columbian Exposition, Chicago, 1893
TRADE ELECTROSE MARK REG. U.S. PAT. OFF. & FOREIGN COUNTRIES
Medal and Diploma received at World's Fair, St. Louis, 1904
INSULATION
"MADE IN AMERICA"
LOUIS STEINBERGER'S PATENTS
LIGHTNING-PROOF INSULATORS
1,000 TO 1,000,000 VOLTS
Insulators Are Standard with
United States Navy and Army
AND WIRELESS TELEGRAPH AND TELEPHONE COMPANIES
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The Wireless Age

Edited by J. ANDREW WHITE E. E. BUCHER, Technical Editor

Vol. 6 Contents for April, 1919 No. 7

Index of Equipment

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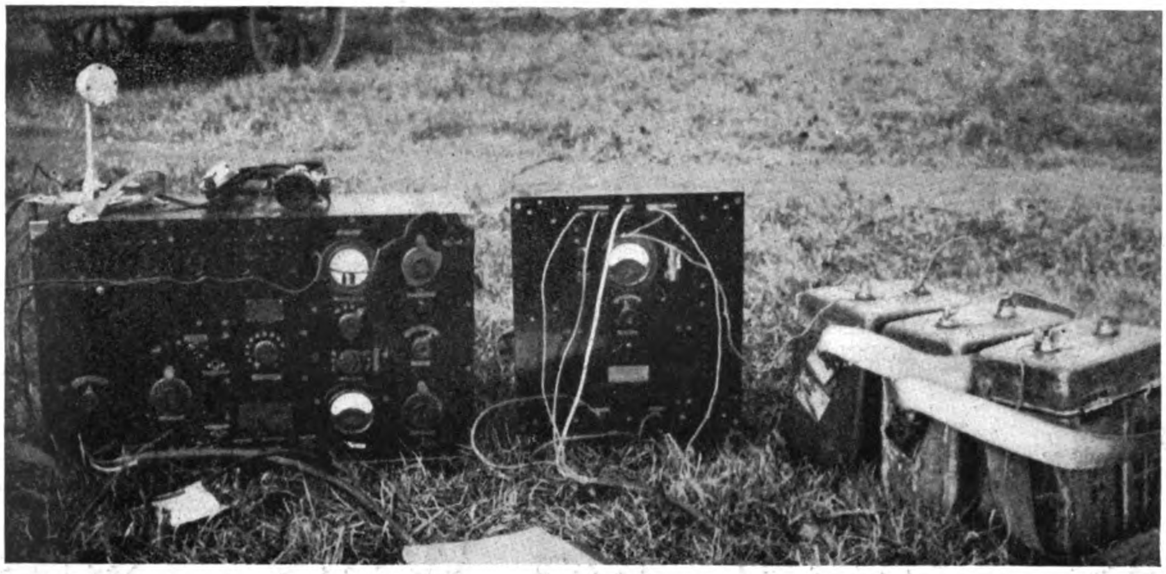
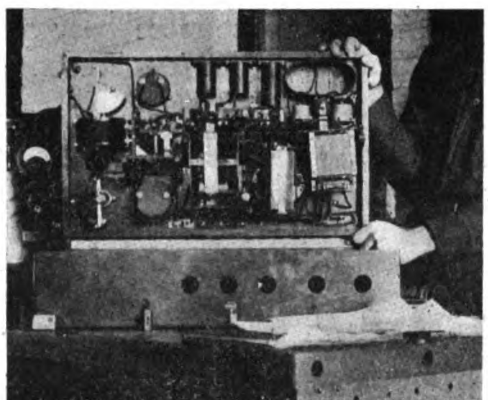


THE ARMY RADIO-PHONE

Of undoubtedly great interest to those who did not get the opportunity to work with Signal Corps apparatus are the three illustrations on this page. Above is the radiotelephone ground set; to the right may be seen its three 4-volt storage batteries; in the center, the panel and 300-volt dynamotor; the head 'phones and transmitter are on the top of the set and the automatic relay control button lies in on the ground.



Interior of the radiophone set illustrated above, showing the arrangements without the vacuum tubes; the dynamotor for supplying positive potential for plates may be seen to the left

AIRCRAFT WIRELESS 'PHONE

The airplane radio telephone set: In the left foreground is the wind-driven generator; alongside is the aviator's helmet with 'phones enclosed in soft rubber; to the left rear is the set containing both sending and receiving equipment with two-step amplifier; alongside, set with interior in view, showing bulbs; there are two transmitting bulbs inside the coil; at the extreme right is the transmitter, leaning against the interplane set used for telephone conversation between the pilot and observer.

VOL. 6. No. 7 APRIL, 1919

THE WIRELESS AGE

WORLD WIDE WIRELESS

Weagant's Disclosure of His Static Discoveries Converts Skeptics

CONTROVERSIAL opinions, which followed the preliminary public announcement in November that Roy A. Weagant, chief engineer of the Marconi Wireless Telegraph Company of America, has solved the problem of eliminating static interference, were noticeably absent when he disclosed the secrets of his discovery on March 5th. The skeptics were converted after hearing his paper, "Reception Through Strays and Interference," delivered before a joint meeting of the Institute of Radio Engineers and the New York Electrical Society at the Engineering Societies Building in New York.

The meeting was attended by eminent scientific figures from all parts of the country and the auditorium was filled. The Weagant paper, which was illustrated with stereopticon designs, consumed in its reading nearly two hours. He was given a hearty round of applause at the conclusion of his address, at the end of which Prof. Michael I. Pupin of Columbia University, an early critic of Weagant's claims, arose from a front seat to acknowledge the discovery and invention which had hitherto been targets for his skepticism.

"We have here a momentous step in advancing the art of telephony," he said. "It is a marked improvement in the problem of getting rid of static, a great step. It should be hailed with delight by electrical scientists."

American-Built Lafayette Station Sold to France

THE sale of the great Lafayette wireless station at Bordeaux to the French Government at a price of approximately $4,000,000, and many hitherto unpublished facts of American naval activities in the war were announced here today by Assistant Secretary Roosevelt, who arrived at Boston with President Wilson on the George Washington on February 24th.

"The great Lafayette radio station near Bordeaux was intended to insure communication between Washington and the army and navy in case the cable system was put out of commission or interfered with by German submarines," Mr. Roosevelt said. "It has eight towers, and could communicate with the United States day and night. It was built by the navy. I arranged with the French Government that we shall complete the station, which is two-thirds finished, and they will then take it over at what it costs us, about 22,000,000 francs."

Ten Wireless Stations for Scandinavian Countries

IT is announced in Lloyd's List and Shipping Gazette that a large radio telegraph station has recently been erected at Karlsborg, in Sweden.

The station has a radius of 5,000 kilometers (about 3,100 miles), and will thus be able to communicate directly with America.

In addition to the Gottenborg and Karlskrona stations three others are being built in Sweden—at Boden, Hernosand and Vaxholm, near Stockholm. The station at Karlsborg has two masts, each 210 meters high. The aerials between the masts consist of six wires 450 meters long. The electric current is supplied from the Trollhattan hydroelectric power station, and is converted at the station to a periodicity of 15,000.

Telephone equipment installed in the President's room on board the steamship George Washington

In Norway the Stavanger station is nearly finished. It will communicate with America, where the Marconi Company has built a sister station. Its radius will be equal to that of Karlsborg.

Rundemand station, near Bergen, with a radius of 800 to 1,100 kilometers, has been in use some time, and Tryvand station, near Christiania, will be ready in the near future.

Radio Devices for Mapping Arctic Regions

AN important contribution toward the success of the Roosevelt Aerial Arctic Expedition, to be headed by Captain Robert A. Bartlett, was announced at the thirteenth annual dinner of the Aero Club of America. John Hays Hammond, Jr., stated that he has devised a system by which maps of the Arctic regions may be made with unprecedented speed and accuracy through the use of radio devices.

Mr. Hammond, in his address, said in part:

"The war has contributed three important scientific developments for the purpose of exploration—first, the aeroplane; second, the application of radio signaling to aircraft; and, third, the development of aerial photography.

"I have devised a system, the main principles of which are extremely simple, embodying these three technical developments in a system of aerial surveying, utilizing which it should be possible for vast tracts of territory to be mapped with accuracy and speed never before attained in mapping.

"It is hoped by the Aero Club to apply this system in the exploration of the Polar basin, a vast territory, concerning which man has but little knowledge. We hope to achieve by the use of these new instrumentalities the results in a few months which before would have required years of the enduring and almost superhuman struggle which characterized Admiral Peary's extraordinary achievements."

Mr. Hammond then explained that a number of radio direction-finding bases would be established on a base line from Mackenzie Bay to Cape Columbia. The airplanes used for exploration would be equipped with radio transmitters.

Then the aviator, at a rate of eighty miles an hour, will fly over the regions. By various tests he will distinguish land from ice floes, and once he finds land he will fly along its contour, encircling it. His signals will be picked up by the finders along the base line, keeping check on his movements.

A photograph is taken from the machine at each signal. These pictures all attached will show a progressive outline of the coast and can be checked up by the chart made at the base line stations.

Patriotism and Profits Revealed in American Marconi Report

IN the annual report of the Marconi Wireless Telegraph Company of America the operations for the fiscal year show, before allowing for reserves, a net income of $998,358.14 as compared with $780,592.44 for the year 1917.

The net profits for the year, after utilizing $286,516.37 for reserves, amounted to $711,841.77 as against $617,772.69 in 1917, or an increase of 15.23 per cent. This amount has been added to the surplus, increasing that account, after payment of $499,975.00—1918 dividend—to $1,631,415.78 at December 31, 1918, and the reserves set aside at that date for depreciation amount to $629,176.27 additional.

The directors call attention to the dividend of 5% per annum which was paid August 1, 1918, and to the declaration of another dividend of 5% per annum payable July 1, 1919, to stockholders of record June 1, 1919.

Noting that the company continued in 1918 its whole-hearted efforts to cooperate with the government in every way possible, in the conduct of the war, the report observes:

"Of approximately 1,200 male employees on its roll, 456 were numbered in the stars of its service flag, and seven were called upon to make the supreme sacrifice for their country." Mention is made of the official recognition of the company's war service expressed by Commander S. C. Hooper, of the Navy Department, which The Wireless Age published in its earlier account of the hearings on government ownership of wireless. The testimony of the Marconi officials before the House Committee is made a supplement to the report, with a caution to stockholders to remain on the alert and to protest against any new attempts to pass measures destructive to the business of the company.

Sound Transmission by Rays of Light Reported from London

A COPYRIGHT dispatch from London to the Press Publishing Co., stated under date of March 8th, that the London Daily Express understands that wireless telephony by the use of light rays has been discovered and successfully experimented with by a young doctor of physics at University College of London. A message sent by the new wireless telephone is, in effect, a spoken heliograph, and wherever it has been practicable to send a Morse code heliogram by flashes it will be possible, when the invention is developed, to send spoken words. The experiments were carried out for the Admiralty during the war. Mr. Balfour, then First Lord of the Admiralty, and Admiral Beatty, sitting in a flagship in the Firth of Forth, were able to talk over the light ray telephone direct to the Admiralty and receive messages back. Later the apparatus was placed in submarines and used with success.

Hammond's Wireless Controlled Craft Approved

ARMY and navy experts have reported favorably on the device of John Hays Hammond, Jr., for radio control of surface craft to be sent laden with explosives against enemy ships. They predict similar results with submerged craft showing above water only wireless antennæ.

Before finally deciding on the purchase of the patents for $750,000, the board desires further experiment with the submerged craft and a change in law for the experiments is necessary to permit building so as to make success certain before purchase.

Construction of the submerged craft which will be about 80 feet long, by 7 feet in diameter, will take two years, according to Mr. Hammond, who told the committee he has spent ten years and $400,000 on his invention.

"There is no question whatever as to the ability to control with great accuracy the torpedo or carrier, whatever kind it is," said a letter to Major-Gen. F. W. Coe, a member of the board, "so long as it is a surface vessel or has any antennae above the water, by direct radio waves, either from shore or from airplane.

"The board had before it also, and considered, the ability of the enemy to interfere with the control of the vessel by radio energy. Mr. Hammond's claims are that no interference can be had with the craft outside a radius of 100 to 250 yards from the source of the energy; that is, from the radio plant of a battleship, for example.

"Within such a radius a certain interference from a powerful wireless station is possible, but that interference with the apparatus only operates to keep the torpedo on a fixed course on which it may be running."

With a shore station having a height of eighty feet above sea level radio control of the craft has been demonstrated to the board up to a distance of about seven miles.

"A surface launch with the apparatus on it," said Gen. Coe, relating demonstrations before the board, "was controlled from both the shore and from an air-

plane, the means of control in each case being the same. The board also witnessed the dropping of depth charges from the stern of the boat while it was proceeding on any desired course."

Gen. Coe said he had run the craft "all around vessels coming into the harbor at will," and at close ranges there would be no difficulty in ramming a vessel from shore.

Mr. Hammond said an aviator after four hours training on control was able from a height of 9,000 feet and a distance of six or seven miles to exercise absolute control over the high speed boat.

Overseas Radiophone Talks a Certainty

CONVERSATIONS by wireless with Europe were predicted for the near future in a newspaper interview given by Edward J. Nally, vice president and general manager of the Marconi Wireless Telegraph Company of America, who returned on March 9th on the Dutch liner Nieuw Amsterdam, after spending five weeks in France and Belgium arranging for the resumption of the normal flow of commercial wireless and for the installation of the recently developed system of radio telephony.

"The scientists of Europe are greatly impressed and enthused with the discovery by Roy A. Weagant, which eliminates the static troubles that hitherto have been the bane of wireless communication in bad weather," Mr. Nally said.

"In the not very distant future you will be able not only to use your telephone to call up a friend in Chicago or San Francisco and converse by wireless, but the radio telephone soon will be developed to a point permitting similar talks from America to Europe.

"It is now possible to use the telephone you have at home in connection with the wireless, thereby cutting down, as the installation of wireless apparatus on telephone systems grows, the need for more telephone trunk lines, and thus doing away with an increase in the material used in construction of telephone trunk lines."

Congressman Believes Wireless Development Has Doomed Wire Systems

ALL the telegraph and telephone poles, wires and instruments will amount to "scrap" in a year if the progress now being made in wireless communication continues, Representative Steenerson, of Minnesota, ranking Republican member of the House Postoffice Committee, predicted on January 30th.

"Radio communication is the coming thing," Mr. Steenerson said. "It is making such rapid strides that before the end of the year the average American will not be bothering much about the transmission of an ordinary message over an ordinary telegraph or telephone wire or as to whether the ordinary telephone or telegraph wire is owned or controlled by governmental or private interests."

Congressman Steenerson declined to comment upon the report that most of the telegraph and telephone companies would be glad to turn over their properties —which they now estimate to be worth about a billion dollars—to the government, if they would be permitted to invest their capital in wireless communication which they are said to regard as certain to supplant present methods.

Testimony given before the House Merchant Marine Committee as to the possibility of radio communication replacing present methods, Mr. Steenerson added, bore out his argument that "there was no reason for anybody to become unduly excited over the question of government ownership of wires."

"It will mean," he said, "that the properties of the Western Union Company and the American Telegraph and Telephone Company, as well as that of the Postal Company, will change so in form as to represent systems not at all comparable with their present ones."

Public Given Opportunity to Converse with Aircraft by Wireless 'Phone

NEW YORKERS had the unique privilege of listening to wireless telephone conversations with a squadron of airplanes which soared over the city in battle formation each afternoon during the period of the Aeronautical Exposition, held from March 1st to March 15th. The squadron flights were controlled entirely by wireless telephones installed in Madison Square Garden and the 69th Regiment Armory, the buildings in which the aircraft exhibits were housed. The demonstration was an official part of the government's feature at the exposition.

The novel feature was the privilege given to the general public to wear flying headgear and helmets during the period when formation flying was under way. Visitors were permitted to converse with the squadron commander, and also listen to the orders given from the ground, and from the squadron commander to the rest of his pilots.

Andrew A. Allan of Canadian Marconi Company, Dead in Montreal

THE loss of a pioneer in commercial wireless was recorded when Andrew Alexander Allan, a member of the well-known shipping family of Montreal, died on February 11th, in that city. He was the son of the late Andrew A. Allan, founder of the Montreal Ocean Steamship Company, whose vessels were operated as the Allan Line of steamships. He was born in Montreal June 15, 1860, and was educated at Rugby, England, and by private tutor. For almost his entire business life he was identified with the Allan Line. He was also connected with several other large corporations, having been, up to a few weeks before his death, the president and a director of the Marconi Wireless Telegraph Company of Canada, the shipping Federation of Canada, and the Dominion Dry Dock Company.

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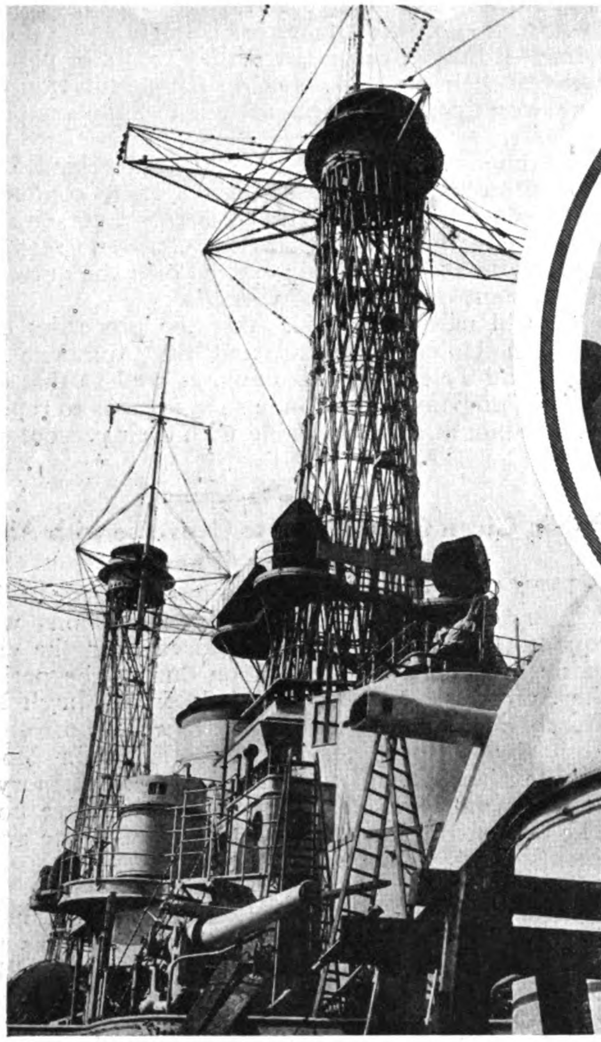
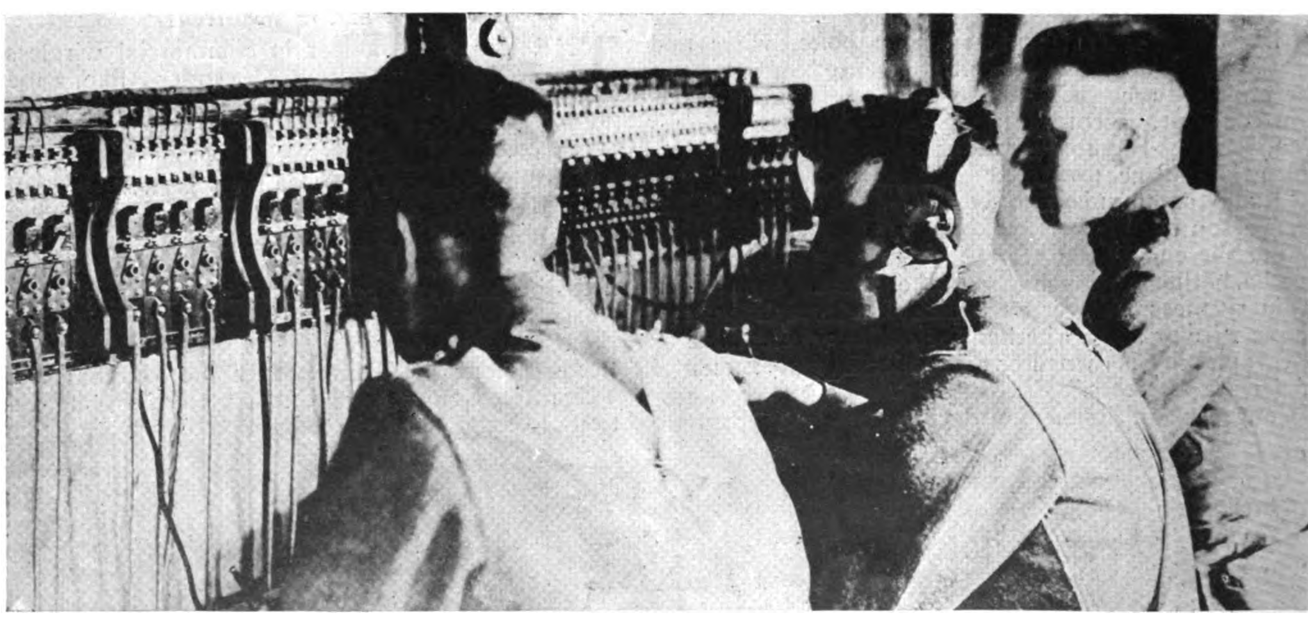


Army and Navy Methods

An interesting arrangement of wireless aerials to obtain extra capacity may be noted in the view of the U. S. S. Idaho, on the left; in addition to the usual double triangular form of antennae on hexagonal spreaders, festoons of ring-spread wires are draped from the masts. In the circle, above are two of the army's wounded, one-armed heroes mastering buzzer communication



Work of the former 1st Bn. Signal Corps, Pennsylvania militia, is illustrated by the above photo of a telephone and telegraph exchange in Abeele, Belgium, during the latter part of August. Left to right, the men are: Privates H. G. Smith, E. K. Daly and H. R. Shaw, all of Company C, Hdqrs. 108th Regt. Infantry, 27th Division

Weagant's Anti-Static Invention

Details of a Great Discovery Which Has Revolutionized Long Distance Wireless Communication

An abstract of a paper read before a joint meeting of the New York Electrical Society and the Institute of Radio Engineers at a monthly meeting, Wednesday, March 5, 1919.
In Two Instalments.

PART 1

Reported by Elmer E. Bucher

Director of Instruction, Marconi Institute

TO a large and enthusiastic audience composed of radio engineers and scientists of prominence, at a joint meeting of the Institute of Radio Engineers and the New York Electrical Society, held March 5, 1919, Roy A. Weagant, Chief Engineer of the Marconi Wireless Telegraph Co. of America, delivered a paper describing in detail his apparatus for the elimination of the great bug-bear of transoceanic wireless communication—static interference.

So quiet had the details of Weagant's great discovery been kept that few in the audience had the slightest inkling of the fundamental principles upon which the operation of his system is based. And so convincing was the explanation given by the speaker that even the most skeptical were compelled to admit that the discovery was not the result of speculation in theory, but was the outcome of a progressive series of orderly, scientific investigations founded on sound scientific principles.

In the subsequent discussion of the paper, one of the first to laud the inventor was Dr. Michael Ivadorsky Pupin, world famous scientist, who remarked that whatever may be our opinion of the theory advanced supporting a seemingly vertical propagation of static, the outstanding fact remained that Mr. Weagant had demonstrated beyond all doubt that his apparatus was a practical operative proposition and, after all, this was the all-important thing to be considered.

He congratulated the inventor on the success attained and remarked that the discovery was one great stepping stone toward the final solution of the ideal wireless system. He hoped that radio engineers would now give their attention to the development of an amplifier which would permit transoceanic communication with very small powers, for, as he jocularly remarked, the average college professor with his limited pocketbook could not accustom himself to think in terms of 200 kw. radio frequency alternators and enormous receiving aerials such as now are employed! He felt, however, that the commercial success of transoceanic communication is now assured.

David Sarnoff, Commercial Manager of the Marconi Company, brought out the fact that for the first time in the history of electrical communication we are enabled to establish a telephonic service between countries separated by the oceans, noting that in the some 60 years of the practical applications of electrical signaling, no solution of the problem had even been suggested. He also threw an interesting sidelight on the inventor's ideas regarding nature and its laws, declaring that Mr. Weagant once remarked that he could not conceive that Mother Nature, having given to mankind such a priceless boon as wireless communication, would deliberately put into force another unsolvable law which would destroy its usefulness. Mr. Weagant had held to this belief firmly, and his subsequent success would seem to indicate that his discovery had initially more of the nature of an inspiration than had ordinary scientific achievements.

G. H. Clark, Expert Radio Aide, U. S. N., who had been assigned to the U. S. Navy Department to witness the experiments of Weagant, testified to the indefatigableness of the inventor, ascribing his success to stubborn persistence and willingness to abandon a mere theory in favor of an experimentally demonstrated fact. He stated that he was amazed at the results secured in the very earliest experiments, which he was privileged to witness, and that, concerning the ability of the Weagant system to weed out static, there could be no doubt.

F. N. Waterman, who has been closely associated with Weagant from the inception of the invention, praised the inventor for his daring in attacking a problem of such magnitude and declared that it was the ability of Weagant to recognize the fallacies of all previous systems purporting to eliminate static that enabled him to evolve a practical method of wireless reception of wonderful, commercial and scientific value. He recounted in a most interesting manner the results of early experiments, and the many obstacles and discouragements met with and overcome.

He stated that after complete success had been attained, it was almost uncanny to pick up a telephone receiver, at a long distance radio receiving station, in which the crashes of atmospheric electricity were so loud that it was next to impossible to detect the wireless signal, and then to simply throw a switch and note the static disturbances disappear to a degree that required a trained ear to hear them; and simultaneously to note the wireless signal so increased in intensity as to make it easily readable.

E. F. W. Alexanderson, of radio frequency alternator fame, said that when it was first mentioned that a hitherto unknown law of nature had been uncovered, he was somewhat skeptical regarding it, but now it was plainly to be seen that the speaker of the evening had made a discovery which gave practical results.

Previous to the meeting much speculation had existed regarding the newly observed law of nature disclosed by Weagant's experiments, and while the speaker plainly asserted that his theory regarding the origin of a particular type of static may yet call for some revision, the reported results of his researches, in a large measure, justified, in the judgment of those present, the belief that Weagant had observed and made practical use of a hitherto unknown static phenomenon.

Classification of Static or Strays

As a beginning, Mr. Weagant first classified strays after the well known method of Eccles, pointing out from his observations the distinction between the types that represented genuine obstacles to transoceanic communi-

cation and those which caused but occasional interference and could therefore be ignored. Static disturbances due to local lightning and snowstorms were ignored, for the reason that these types are of so infrequent occurrence as to be of negligible importance; but there remained the three types, termed, "grinders," "clicks" and "hissing." The last named, which are due to an actual discharge from the aerial to the earth, give no trouble in the ungrounded aerials used in the Weagant system. Of the remaining two types, "grinders" and "clicks," the former were found to constitute the major source of difficulty.

Some Fallacious Ideas Exposed

The success of Weagant's endeavors to eliminate from the receiver the most troublesome forms of atmospheric electricity may be attributed primarily to his clear recognition of the limitations of all so-called static elimination previously evolved.

Take, as an example, the well known receiving circuit in figure 1. His experiments and observations revealed that the static currents induced in the aerial system, A, L-2, L-3, E had the *frequency* and the *damping* of the antenna circuit itself, no matter what frequency of oscillation to which it happened to be adjusted. It therefore became evident that if one were to separate, by any sort of a device, the static currents in the antenna system from the signal currents, he would be confronted with the proposition of separating two currents of the same frequency in the same circuit.

Experimenters, heretofore, had tried to get rid of static interference by detuning the antenna circuit, by differentially combining two radio frequency receiving circuits, by differential connection of two detectors of different characteristics, by differentially combining two audio frequency circuits, as in DeGroot's method, and finally by the use of the Dieckmann shield.

The hoped-for results in detuning the antenna circuit could not be realized because such detuning did not reduce the intensity of the static signal, but simply changed its frequency. The loss, in the transfer of static energy to the secondary circuit when tuned to the frequency of the incoming signal, is exactly the same as the loss in intensity experienced by the signal currents through detuning the antenna. This, of course, does not improve conditions in the slightest, for it reduces the static and the wireless signal in the same ratio.

Some improvement has resulted from the use of loose couplings between the primary and secondary circuits, provided there is a marked difference between the damping of the signal and static currents; but the relief was by no means sufficient to be of any considerable value when working over great distances.

The "interference preventer" next came in for well deserved criticism and was proven by Weagant to be ineffective. As many of our readers are aware, Fessenden coupled, differentially, the two legs of a branched aerial, or the primary circuits of two separate aerials, to a common detector circuit as shown in figure 2. He concluded that if one branch, say A, be tuned to a transmitting station and the other branch, B, be detuned, static currents of equal intensity would be induced in both sides and would be annulled, and that, as the signal in one branch had little or no opposition from the other branch, it would be heard. He assumed the static currents to be forced oscillations and, therefore, that their frequency and intensity were unaffected by an amount of detuning that would *greatly affect* the signal. This, as Weagant clearly pointed out, is an absolute fallacy.

The fact is, that when one branch of the antenna circuit is detuned, the frequency of the static signals changes accordingly, leaving static currents of one frequency in one branch, and of different frequency in the other branch. It is, obviously, not possible to *balance out two opposing E.M.F.'s of different frequency*. Moreover, the detuning of one branch affects the intensity of both the signal and static currents in the secondary circuit in the manner just explained.

It is important to note here that two opposing E.M.F.'s can completely neutralize each other *only* when they have the *same frequency, the same wave form, and opposite phase*. And in the case of damped oscillations, in addition to these requirements, the dampings of the two E.M.F.'s must be identical. The writer feels assured that readers will at once recognize that the steps by which Mr. Weagant eventually arrived at the result attained in his receiving system, constitute one of the most original applications of engineering principles ever made in radio telegraphy.

Continuing, Mr. Weagant said that if any experimenter had secured worth-while results by means of a differential audio frequency circuit, such results have been due to the looseness of coupling involved in the circuits under test. He pointed out also that the effectiveness of balanced detector circuits is due solely to the protection against loud crashes afforded to the ear of the operator. Re-

Points of Interest Disclosed by Weagant's Experiments

The static currents induced in a receiving aerial by static "waves" are of the same frequency and of the same damping as the complete receiving system.

When the oscillation frequency of the antenna circuit is altered by local tuning, the frequency of the static currents changes in accordance.

For that reason, the differentially connected, branched aerial system proposed by Fessenden is ineffective in reducing static; for when one branch is detuned to the wireless signal, static currents of different frequency exist in the two different branches. Obviously, two currents of opposite phase but of different frequency cannot be made to neutralize one another.

Mr. Weagant's researches prove that all forms of static eliminators utilizing differentially connected audio or radio frequency circuits, are of little or no value for continuous long distance wireless reception.

The dominant type of static waves, called "grinders," apparently is propagated vertically in respect to the earth. Therefore the static "waves" resulting therefrom are at right angles to the wireless waves. By the use of properly disposed aerials advantage can be taken of this phenomenon to separate the static and the signal currents.

Two closed circuit loop antennae, spaced ½ wave length from center to center, the planes of which are in the path of a passing wave, will be acted upon simultaneously by the vertically propagated static waves, but at different times by the horizontally propagated wireless waves.

Hence, when both loops are correctly coupled to a common receiving set, the static currents will be in phase and may be neutralized. The signal waves will be out of phase and will not neutralize, but will add their E.M.F.'s vectorially.

By proper adjustment of the phases of the currents in one loop, in Weagant's antennae system, uni-directional reception is possible, signals of maximum intensity being secured from waves arriving at one end of the loops, while interference from the other end of the loops may be annulled.

Underground or surface-ground aerials act as ordinary closed circuit loops erected above earth. By reason of the capacity effects between the ends of the aerials and the earth, a return path for the induced currents is afforded, which effectively closes the circuit.

The greater the capacity per unit length between the underground or surface-ground aerial and the true underlying earth, the shorter is the maximum length which can be used to advantage. This accounts for the fact that approximately 2500 feet is the maximum length that can be employed for underground aerials placed under brackish water.

garding the Dieckmann shield and the ability of the combination system to reduce static, as described by DeGroot, the speaker declared that he could see no basis

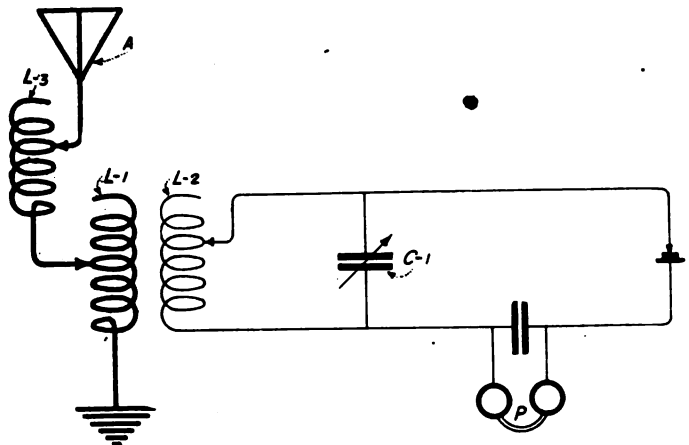


Figure 1—Diagram of an ordinary receiving system in which, as Mr. Weagant points out, the frequency and damping of the static currents are the same as that of the complete receiving system itself. As a consequence, when the oscillation frequency of the antenna circuit is changed by local tuning, the frequency of the static currents change accordingly

therein for differentiating between static and signals, and that investigation had proved that the problem of screening out any electromagnetic wave of any sort, either signal or static, cannot be solved by that method.

For experimental observations Mr. Weagant constructed various forms of aerials, including the horizontal linear—underground and surface-ground aerials. Some of these were found to appreciably reduce static, but the general characteristics of the underground type proved, under experimental investigation, to be entirely different from theories recently advanced. Mr. Weagant's deductions in respect to this aerial will be stated further on.

Some Important Observations Regarding Static

In an effort to determine, by means of the Marconi-Bellini-Tosi direction finder (shown in figure 3), whether or not static was horizontally directed; that is, if it originated from any particular direction at certain hours, Mr. C. H. Taylor, a Marconi engineer, carried out a series of experiments at Belmar, N. J., with apparatus designed for the reception of long waves over great distances. Experiments were also carried on by Mr. Weagant, at Belmar, and simultaneously at another station erected at the Marconi factory at Aldene, N. J.

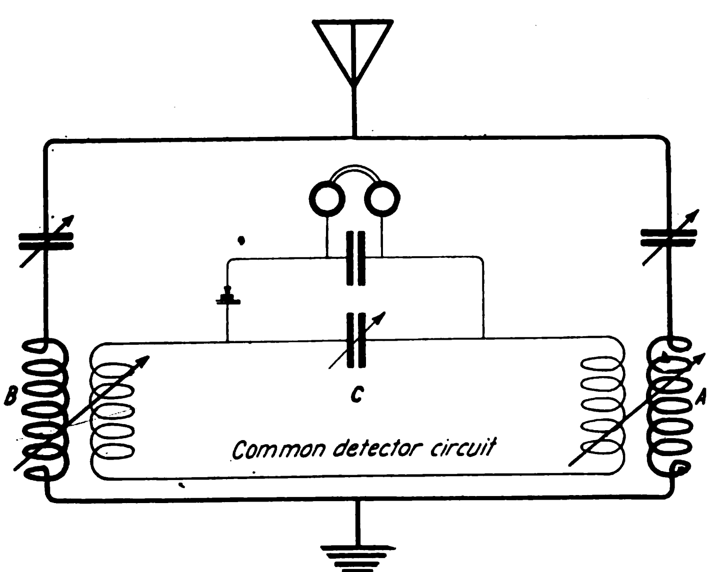


Figure 2—Circuits of the "interference preventer," which Mr. Weagant proves to be ineffective in reducing static. When one branch, say A, is detuned to the wireless signal, the frequency of the static currents change accordingly; hence, static currents of one frequency flow in one branch and of another frequency in the second branch. It is obvious that two currents of different frequencies cannot be made to neutralize each other

These tests seemed to indicate conclusively that the dominant type of static—"grinders"—apparently came from no definite direction, but *gave an equality of disturbances from all points of the compass.*

A further check on this observation was made by rotating a closed circuit loop (see figure 4) connected to a receiving set, about the vertical axis, A. The loop showed equality of disturbances regardless of the direction of the plane of the loop.

These experiments, as Mr. Weagant said, indicated that if static disturbances of the "grinders" type were propagated horizontally, they must come from different directions, and so rapidly that the observer would have no opportunity to manipulate his apparatus with sufficient rapidity enough to determine their direction.

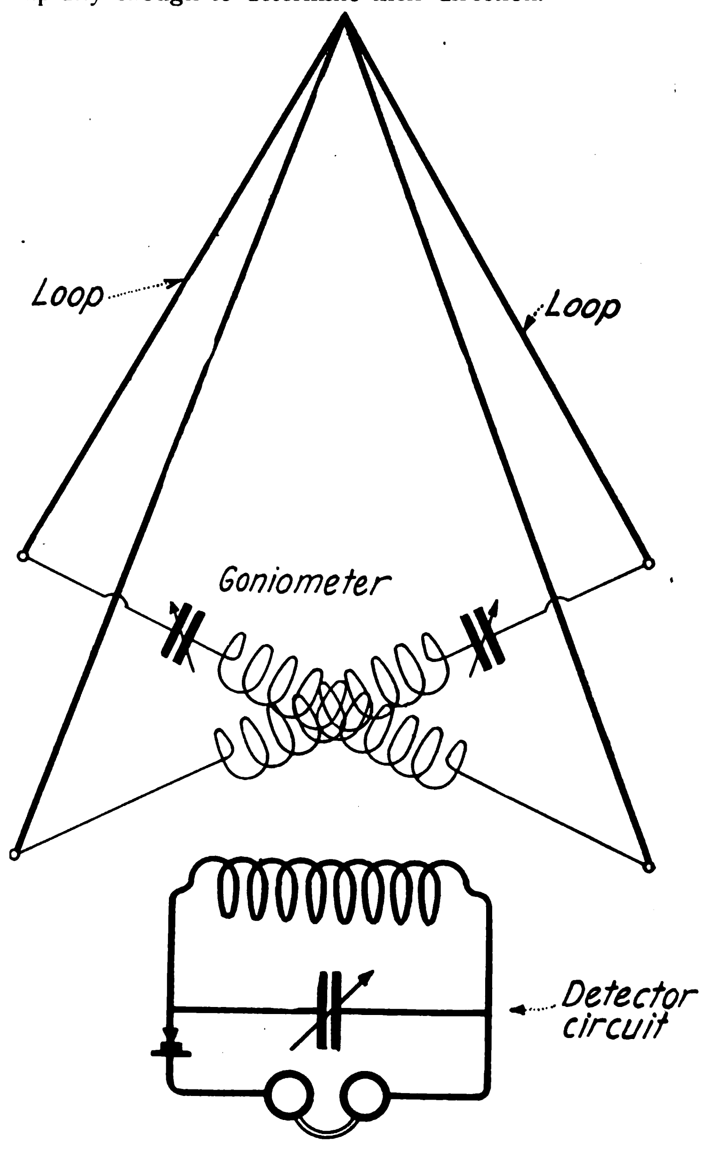


Figure 3—Fundamental circuits of the Marconi-Bellini-Tosi radio goniometer with which experiments were conducted at Belmar, N. J., by C. H. Taylor and R. Weagant to determine whether static signals emanated from any particular direction. The investigation proved that the dominant type of static called "grinders" apparently came from no definite direction but gave an equality of disturbances from all points of the compass

Weagant's Great Discovery

It then occurred to Mr. Weagant that these static disturbances might be propagated *vertically,* instead of horizontally, and if so the *direction of propagation would be at right angles to the direction of the advancing wireless wave.* If that could be definitely proven, then advantage might be taken of the difference in direction to separate the static from the signal currents flowing in the antenna

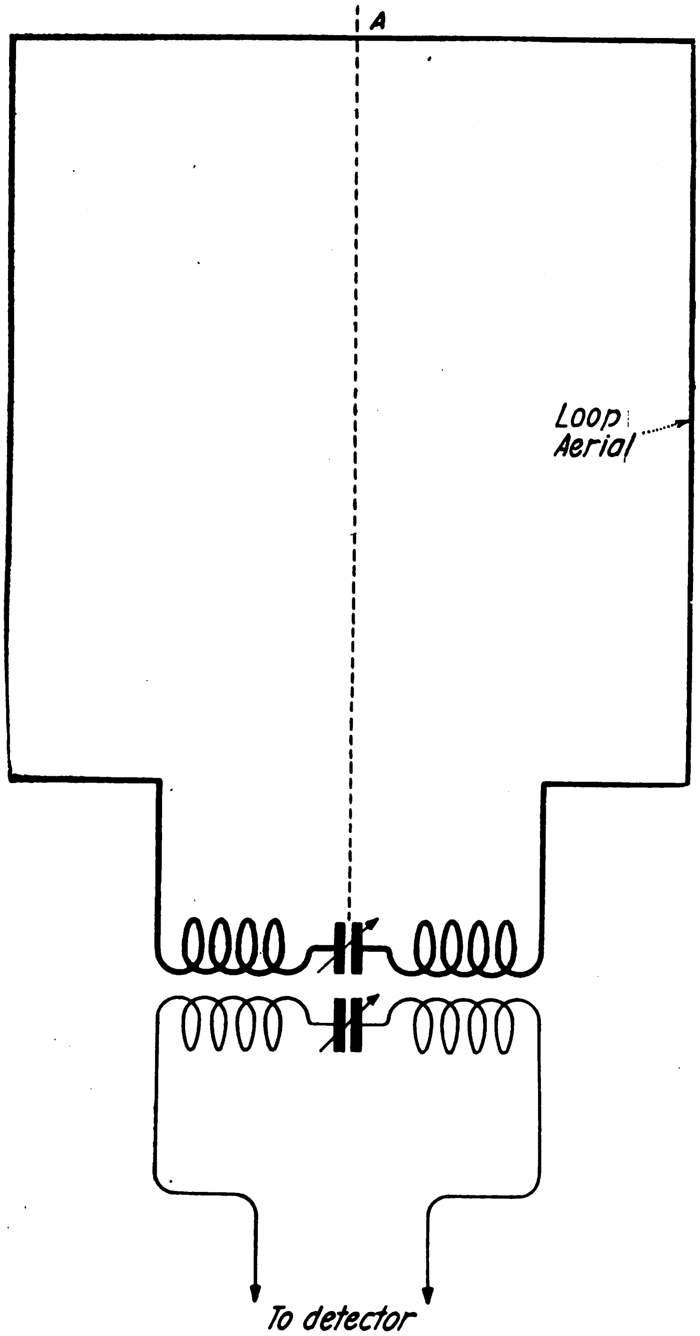


Figure 4—Loop aerial used by Weagant to check up the observations made with the apparatus in figure 3. The loop was rotated on the axis A to determine the line of direction of the static waves. The experiment proved that these waves came from no definite direction

circuit. This was the fundamental working hypothesis on which the Weagant system is based.

A series of experiments to verify the hypothesis then followed.

Observations on Two Loops, the Planes of Which Are Perpendicular

For one thing it was found that when two loops, the planes of which were perpendicular, were connected to a common receiving apparatus, as in figure 5, the static currents *could not be balanced out*. The experiment justified the assumption that *electromagnetic waves responsible for static currents are heterogeneously polarized;* that is, the axes of the oscillators producing them assumed all possible angles in space; and the highly damped waves resulting therefrom are propagated in a direction perpendicular to the earth's surface.

In other words, to the unscientific mind, these static waves may be described as an electric shower which acts upon an aerial, perpendicularly to the earth.

An Early Form of Weagant's Static Eliminator

To determine the correctness of the hypothesis that static is propagated vertically and to ascertain if it were possible on this assumption to devise a system whereby the static currents could be balanced out while the signal was retained, Mr. Weagant erected at Belmar, N. J., the aerials and apparatus shown in figure 6. Two closed loops A and B, each consisting of a single turn of wire 400 feet high with a base line of 1,000 feet, were spaced 5,000 feet from center to center. Two wires, brought from each loop to a receiving station located at the center, were supported on ten-foot poles, 6 feet apart. These leads were connected to the primary coils of a goniometer of the type used in direction finders; the secondary coil was connected to a sensitive oscillation detector. It was this apparatus that permitted the reception of transatlantic signals through static interference of great intensity, whereas without it, it was impossible to distinguish the wireless signal.

The connections to the receiving tuner and detector are shown in figure 6, where loop A has the loading coils L-1 and L-2, the resistances R-1 and R-2, and the coil,

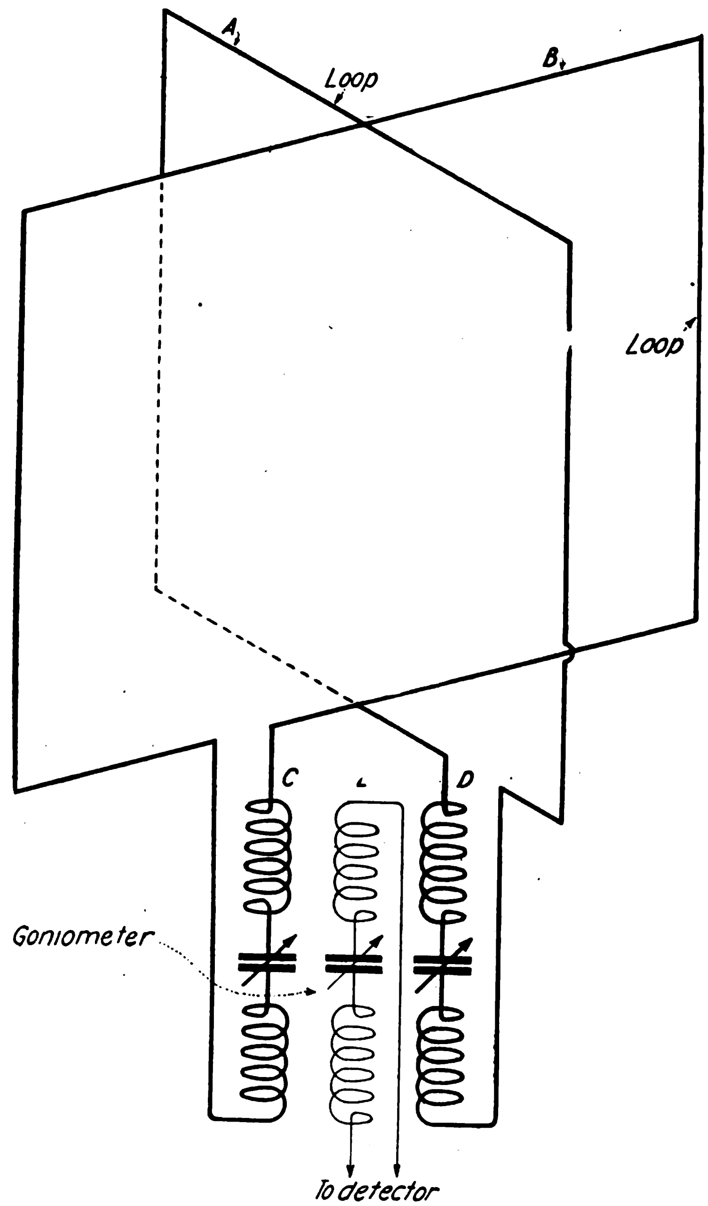


Figure 5—Fundamental circuits of an experiment involving the use of two loop antennae, connected to a receiving set to determine if the static currents could be balanced out while the signaling currents were retained. The test proved fruitless and served to indicate that the electromagnetic waves responsible for static currents are heterogeneously polarized; that is, the axes of the oscillators producing them assume all possible angles in space and the highly damped waves resulting therefrom are propagated perpendicularly to the earth's surface

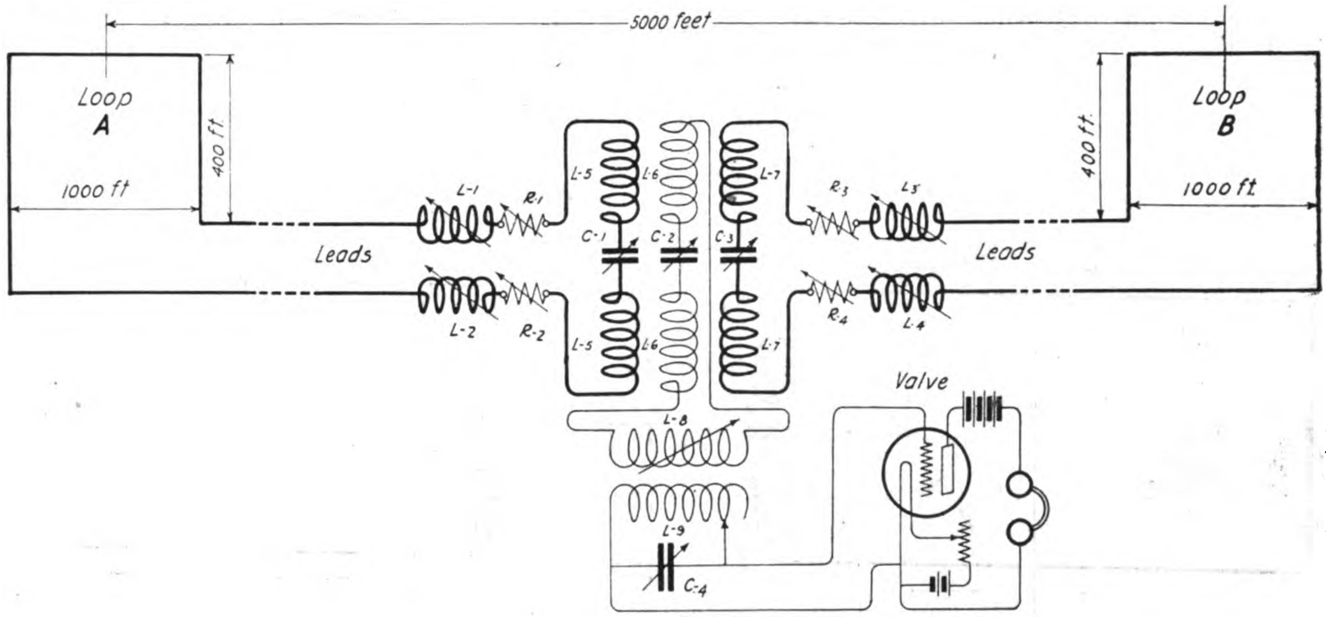


Figure 6—An early form of Weagant's system for eliminating static interference showing two single turn loop antennae spaced 5,000 feet apart. Each loop was 1,000 feet long at the base and 400 feet high. The leads from each loop were connected to the primary coils, L-5 and L-7, of the radio goniometer which were coupled to the secondary coil L-6. By rotating L-6, a position was found where the static currents neutralized and the signal currents were retained. This apparatus and antennae permitted the reception of signals from stations in Europe under conditions of static interference which with ordinary receiving apparatus and antennae would render reception impossible.

L-5, broken at the center point for connection to the variable condenser C-1. The coil L-7 connected to the loop B is similarly connected. Both L-5 and L-7 are coupled to the secondary coil L-6 which is broken at its center to include the variable condenser C-2.

The arrangement of the three coils at the receiving station was similar to that employed in the Bellini-Tosi goniometer shown in figure 7, wherein the rectangular frames L-5 and L-7 are stationary and the rotating frame L-6 is mounted on a vertical axis so that it can be rotated within the resulting magnetic field.

It may be well to describe here the preliminary procedure of adjustment: The coil L-6 is first placed in inductive relation with L-5 of loop A and the incoming signal tuned to maximum intensity. Next, coil L-6 is placed in inductive relation with L-7 of loop B, which circuit is also tuned to maximum signal intensity. Both loops are then connected in and coupled to the coil L-6 which is turned on its axis to receive the maximum induction from both L-5 and L-7. The two primary coils produce a resultant magnetic field which acts upon the rotating coil somewhat after the principle of the radio goniometer.

How the Static Eliminator Works

An explanatory diagram of the system of figure 6 appears in figure 8. Here the two closed circuit loops of figure 6 shown as A′ and B′ are coupled to a common secondary coil L-3 of the receiving apparatus which is installed in a station placed between the loops. The vertically propagated static waves are indicated by the *downward arrows* above the loops and the advancing signal waves which, in this diagram, are assumed to pass from left to right, are represented by the arrows A, A, A, A.

If static waves are propagated vertically, it is clear that they act upon loops A′ and B′ simultaneously and consequently electro-motive forces of equal intensity are generated in both loops and the static currents resulting therefrom flow in the same direction in each loop, as indicated by the single pointed arrows. For purposes of illustration, we have assumed that the static currents flow clockwise in the two loops as shown in the diagram. The current in loop A′ flows downward through the coil L-1 and that in loop B′ upward, through the coil L-2. The two currents will therefore neutralize and consequently none of the static current will flow in the coil L-3.

It now remains to be seen how a useful part of the energy of the signal wave is retained. From figure 8 it is evident that the signal wave acts upon the loop A′ before arriving at the loop B′; and we may assume, for the purposes of illustration, that the arrows A represent the progressive movement of the advancing wave. As the wave motion progresses and the positive half acts upon the loop B′, the negative half of the wave is acting upon loop A′. We will assume that, at a particular moment, its polarity is such that in loop A′ the static current and the signal current pass in the same direction through the coil L-1. The signal and static currents must therefore flow in opposite directions in the loop B′; and inasmuch as coils L-1 and L-2 are coupled to L-3 in such a way that the static currents oppose and neutralize, the signal

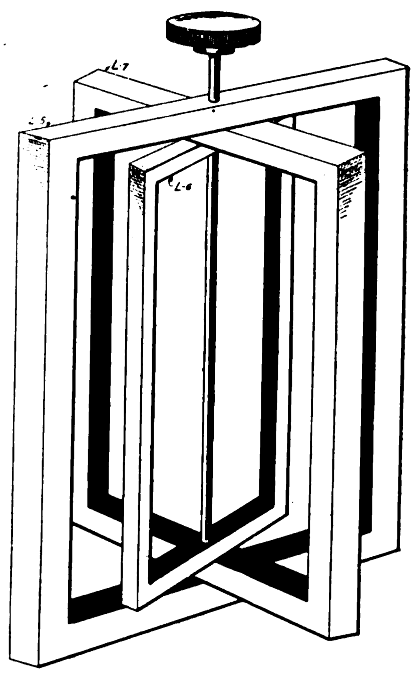


Figure 7—Fundamental construction of the radio goniometer used in the Weagant receiving system. Coils L-5 and L-7 are mounted at a right angle and the coil L-6 may be rotated in the resultant magnetic field

currents must build up in phase and accordingly affect the oscillation detector connected to the terminals of the coil L-3. The principle, of course, holds good when the negative half of the signal wave acts upon B′, and the positive half on A′.

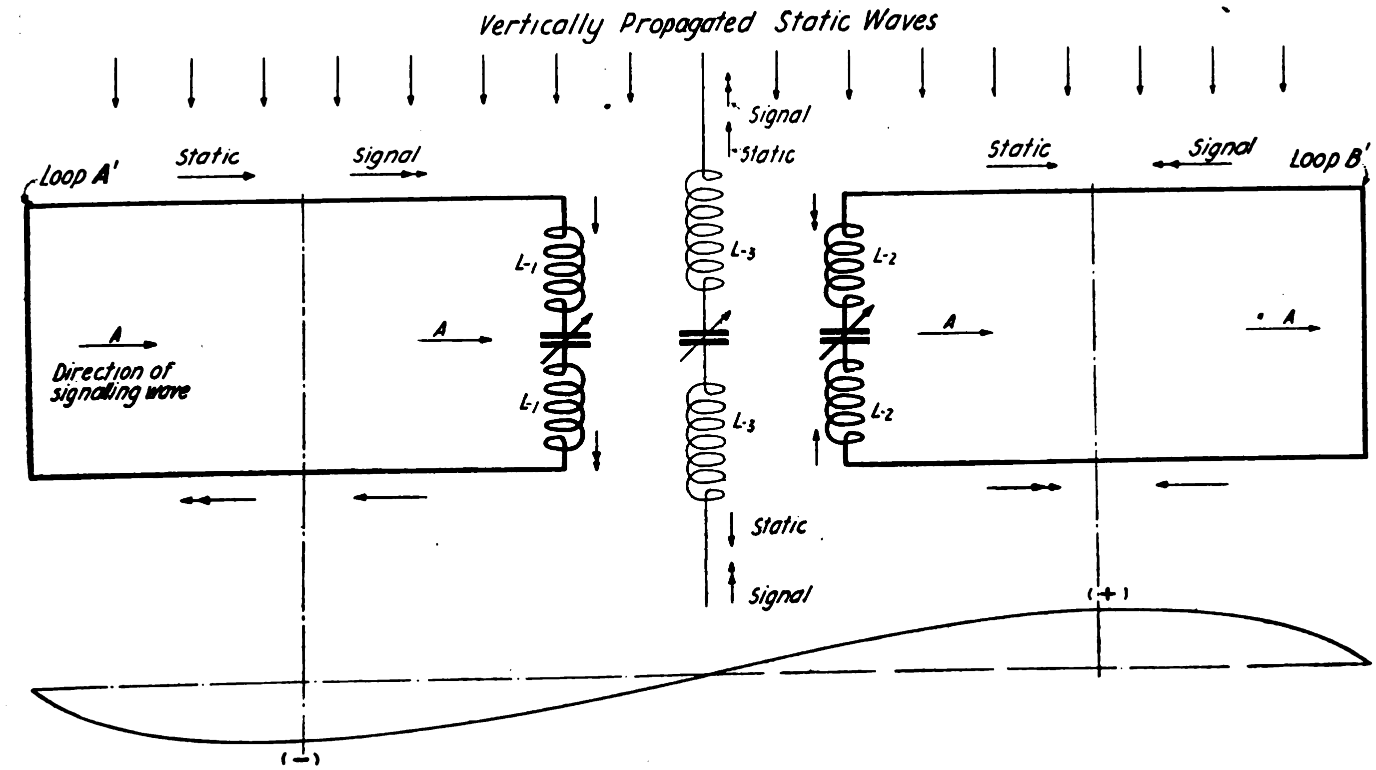


Figure 8—Explanatory diagram of the Weagant static eliminator. Loop A′ is connected to the primary coil L-1 of the goniometer; loop B′, to the second primary coil L-2. Both primaries act upon coil L-3 which rotates in the resultant magnetic field. The vertically propagated static waves act upon both loops simultaneously and the resulting static currents, as shown by the single pointed arrows flow in the same direction in both loops. The static currents flowing in the coils L-1 and L-2 may be made to act oppositely on the coil L-3 and therefore neutralize. On the other hand, the positive half of the signaling wave is assumed to act upon loop B′ and the negative half on loop A′. In loop A′, the signal current and the static current flow in the same direction, but in loop B′ they flow in opposite directions

Since coil L-3 is coupled to L-2 and L-1 in such a way that static currents neutralize it follows that the signal currents must combine. If the two antennae are spaced one-half wave length from center to center, the E.M.F.'s generated in the coil L-3 by the signal currents, will be in phase and the resultant will be the arithmetical sum of these two E.M.F.'s. If the loop separation is equal to one-quarter wave length then the E.M.F.'s will be 90 degrees apart and the resultant E.M.F. will be 1.4 times that of the individual E.M.F.'s; that is, they combine in quadrature. It is not essential that the effective spacing of the loops be one-half wave length; for one antenna can be employed for a considerable range of wave lengths provided one is willing to sacrifice some of the signal current at wave lengths other than that for which the loops give one-half wave length separation. It is evident that the Weagant system can be used in connection with any type of oscillation detector so far devised, and that the operation of the system as a whole is based on a fundamental principle never before utilized in radio communication

The foregoing may be stated in another way by saying that the static waves arrive at the two aerials at the same time, while the signals arrive at the two aerials at different times. Therefore the static currents in the two loops at any instant are in phase and the signal currents are out of phase by an amount depending upon the effective spacing of the two loops in respect to the wave length being received.

The magnitude of the E.M.F.'s generated by the signal waves will always give a resultant depending upon the effective separation of the loops; that is, the distance from center to center of the loops. If this separation is one-half wave length, the E.M.F.'s generated in the coil L-3 by the signal currents from loops A′ and B′ will be in phase and the resultant is therefore equal to the arithmetical sum of these two E.M.F.'s. If the loop separation is equal to one-quarter wave length, then the E.M.F.'s acting on the coil L-3 will be 90 degrees apart and the

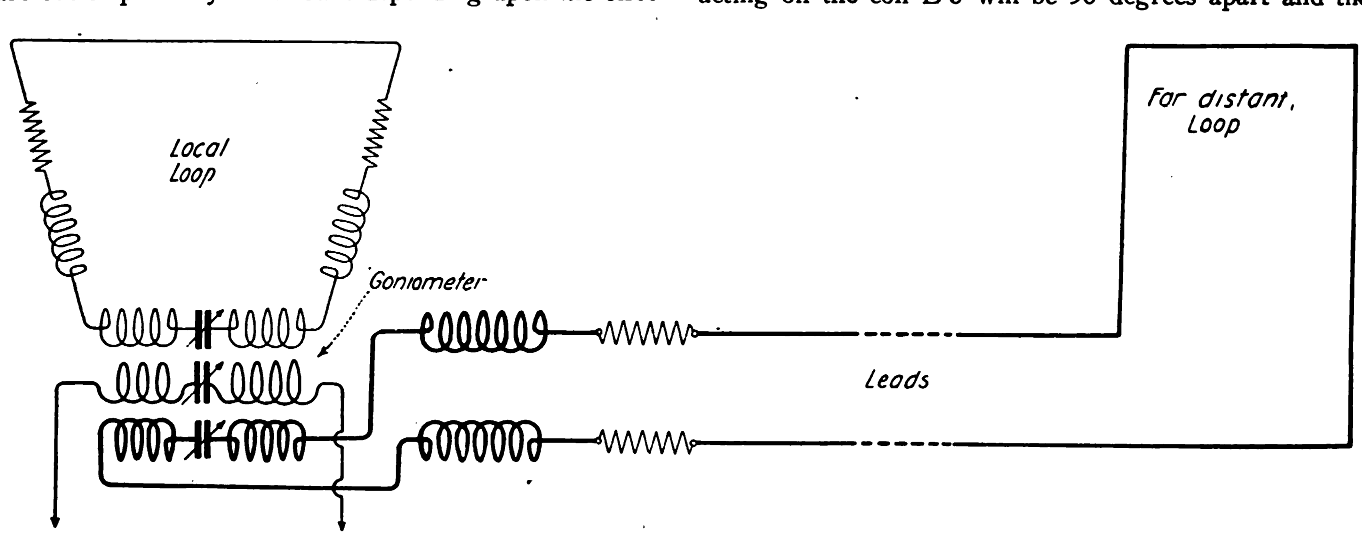


Figure 9—Circuits used in one of the early experiments conducted by Weagant wherein a small closed circuit loop was balanced against a far distant loop. This experiment at first gave a better static balance with a loss of signals and helped uncover the fact that the long low leads extending from the distant loop to the receiving station acted as an antenna, picking up both static and signals which under some circumstances were found to flow in opposite directions. This circuit was abandoned in favor of that shown in figure 6

resultant would be equal to 1.4 times that of the individual E.M.F.'s; that is, they combine in quadrature.

It is clear that the most effective separation for maximum signals is one-half wave length, and, therefore, from any particular wave length, the effective spacing of the loops should be selected to meet the above mentioned conditions. This, however, is not strictly essential in practice. One antenna can be employed for a considerable range of wave lengths provided one is willing to sacrifice some of the signal current at wave lengths other than that for which the loops give one-half wave length separation. This, therefore, is not an objection to the commercial application of this discovery.

Now, if the theory advanced by Mr. Weagant concerning the vertical propagation of static waves were not correct, the results described could not be secured; for, if the apparatus in the receiving station was adjusted so that the signal currents combined vectorially and in accordance with the effective aerial separation, then the static currents would combine similarly, and therefore, the entire system would show the same signal to static ratio as a single loop. Since the experiments proved that the static currents do not combine but are annulled, while the signal is retained, the theory of vertical propagation of static waves is well sustained. However, as Mr. Weagant remarked, if this theory is not correct, it is at least certain that the static waves operate on a sufficient area of both loops, simultaneously, to produce the desired balance described.

In accordance with the principle of the invention, the two loops should preferably be symmetrical in every respect. Controlling appliances permitting proper adjustments to be obtained are shown in figure 6. They consist of the loading inductances, condensers and variable resistances therein indicated.

Some practical results obtained with the system portrayed in figure 6 were reported as follows: Signals were received at Belmar, N. J., from Nauen, Germany, 6,000 and 12,000 meters; Clifton, Ireland, 5,600 meters; Carnarvon, Wales, 14,000 meters; Elivese, Germany, 9,600 meters; and Glace Bay, Nova Scotia, 7,600 meters.

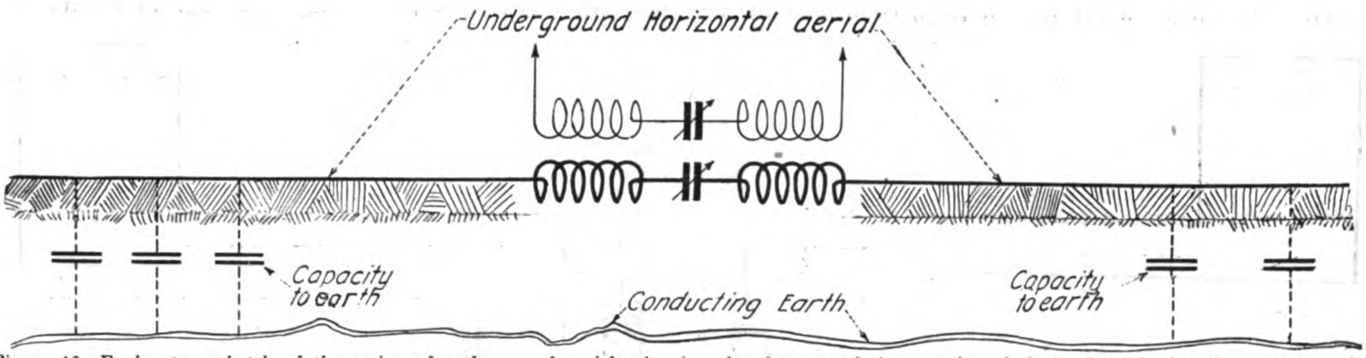


Figure 10—Explanatory sketch of the action of underground aerials showing that because of the capacity of the horizontal wires in respect to the earth, these antennae act as the closed circuit loops of the Weagant system

Mr. Weagant observed that whenever the circuits were so adusted that static disturbances were cancelled or reduced to a minimum, the signals received on the two loops combined, as might be expected from the spacing between them and the wave length of the incoming signal.

It is evident that the spacing between the loops in the diagram of figure 6 is slightly over one-quarter wave length for the wave of 6,000 meters used by Nauen, Germany, during some of the tests. In the case of the 6,000 meter wave, the resultant signal was approximately 40% greater than that due to either aerial alone, while in the case of Carnarvon, at 14,200 meters, the spacing was equal to only 1/9 of the wave length and the resultant signal was materially less than that due to either loop, which was to be expected. The system shown in figure 6 permitted reception from Nauen, Germany, throughout the months of July and August and during the worst static periods of the day. Grinders, of such intensity as to render the signals unintelligible by ordinary receiving apparatus and antennae, were eliminated to such a degree that continuous reception from foreign stations was possible. Other observations, through continued use of the circuits of figure 6, established the fact that the heavier the static disturbances were, the more perfect was the balance that could be secured; with a consequent greater improvement in static reduction to signal ratio. This, as students of wireless telegraphy will agree, is a very desirable characteristic.

A very interesting but erstwhile elusive phenomenon met with in the system of figure 6, was the fact that the long low horizontal leads picked up static and signals as well as the far distant loops, and until this feature was thoroughly worked out, the results obtained seemed to indicate that the farther apart the loops, the less perfectly

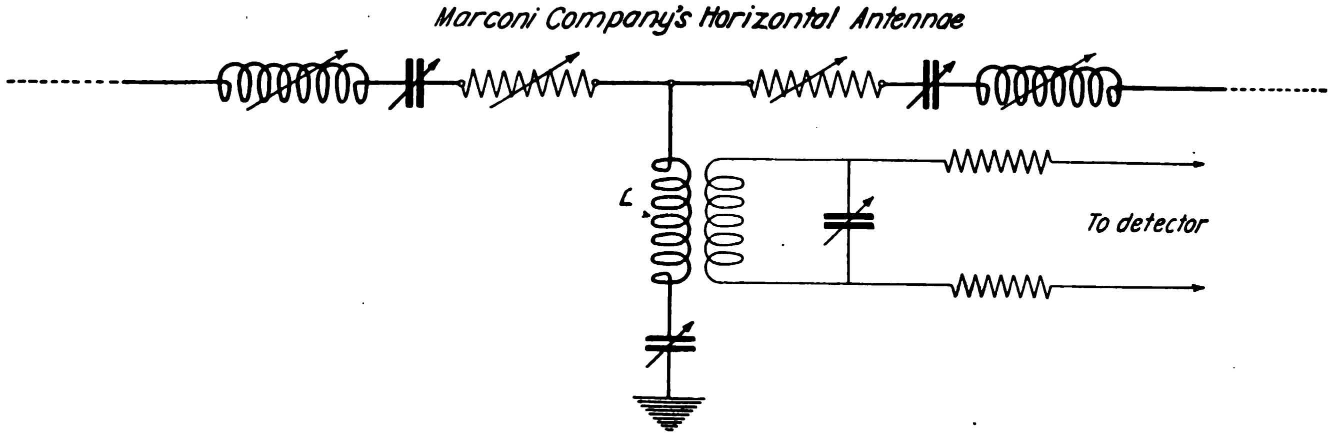


Figure 11—An early experiment conducted by Weagant in which two horizontal aerials were coupled to a detector circuit through a tuning transformer to determine if a reduction of static interference was possible. This and the circuits in figures 12, 13, 14 and 15 following, were found to give an appreciable reduction in static, but not of sufficient magnitude to permit continuous long distance wireless reception

could the static currents be balanced, and also, the converse.

One experiment, seemingly supporting this erroneous belief, made use of a far distant loop, connected to the receiving apparatus through long low horizontal leads, and another loop with short leads erected at the receiving station, as in figure 9. This arrangement was found for the time being to give somewhat better results than that in figure 6, and the improvement was found to result from the more perfect balance thus secured, in spite of the loss of signal.

However, as mentioned above, it was discovered later that the horizontal leads of the two loops as in figure 6, picked up some of the static and signal energy and, as a result, the static currents in a set of leads and in the loop tended to flow in the same or opposite direction. Adjustments that were made in the circuit shown in figure 6, to balance out static currents in the loop, before this fact was recognized, caused the static currents in the leads under some circumstances to add; but the simple expedient of placing reversing switches in the circuits solved the problem.

The results thereafter obtained with the Weagant system were found to be better with the use of greater rather than less effective separation, by an amount proportional to the separation.

It was observed that, in all arrangements employing two closed circuit loops connected to a central receiving station by long horizontal leads, local tuning of each loop was necessary. This was not a very convenient procedure with aerials 3 miles apart, for it became necessary to station an operator at each loop and to inform him, by telephone, what adjustments were to be made.

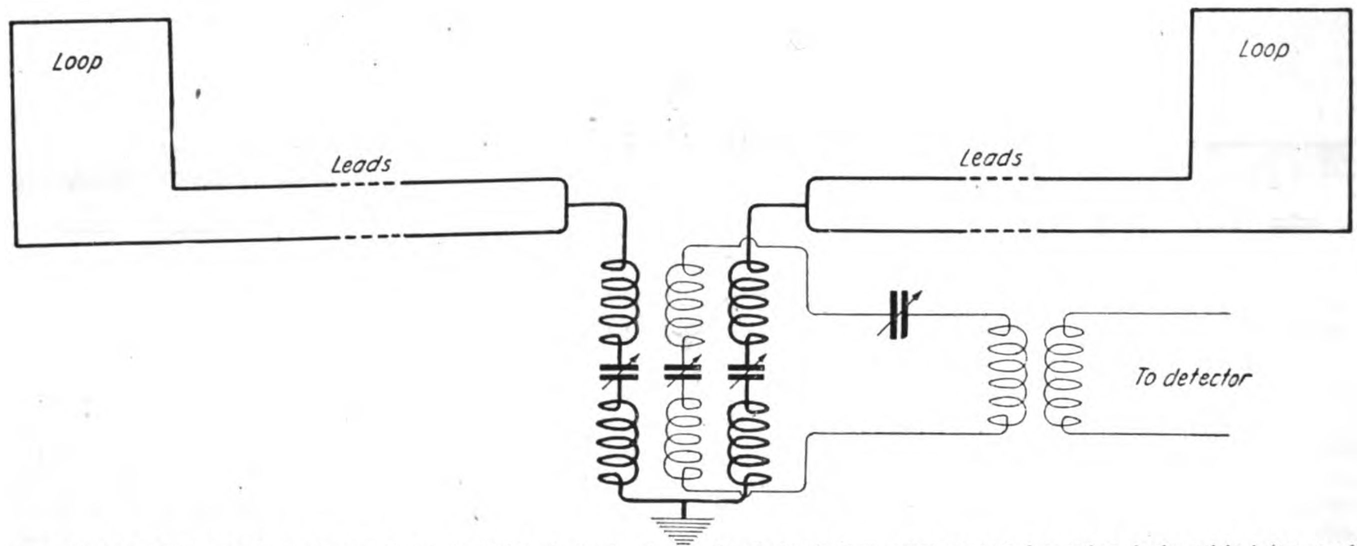


Figure 12—One of Weagant's early experiments in which the leads of two closed circuit loops were connected together, both aerials being coupled to a common detector circuit

Underground and Surface-Ground Horizontal Aerials

The low horizontal aerial for radio reception was first used by Marconi. An antenna of the same type employed by Weagant in the spring of 1914, at New Orleans, gave a distinctly better signal to static ratio, than the large earthed aerial. Later comparisons with a loop aerial showed the two to be substantially identical in that respect.

One important deduction resulting from these tests was the fact that the long horizontal aerials laid under ground, on the surface of the ground, or suspended above the ground, may act as a loop aerial. Because of the capacity to earth (as shown diagrammatically in figure 10) a return path for the currents exists between the ends, which effectively completes the circuit.

It has been noted particularly that, as the distance between the ground and the horizontal aerial is increased, its action becomes more nearly that of an ordinary antenna; and that, because it is then not in the most effective position relative to the incoming signal to collect the maximum of energy, the signals are less in strength than would be secured with less spacing.

Quoting Mr. Weagant:

"The usually accepted explanation of the working of the horizontal aerial is that the wave front of the signal wave is tilted forward and that consequently there is a component of electric force in the direction of its length. It is to be noted, however, that under some circumstances such an aerial may be acting equally well as a loop. An aerial of this type is shown, in figure 10, lying on the surface of the ground and it is evident that by virtue of its capacity to the true conducting earth, a return path between its ends exists and, therefore, it is a form of loop; which method of consideration will account for many of the observed facts, such as its directivity, in a satisfactory way. It will also account for one observed fact which the usual methods of explanation do not account for, namely, that when an aerial of this type is laid on the ground, or buried underneath it, its effectiveness as an aerial does not increase indefinitely with length, but rapidly reaches an optimum value dependent on the circumstances obtaining. This can readily be accounted for under the present hypothesis by the fact that as the length

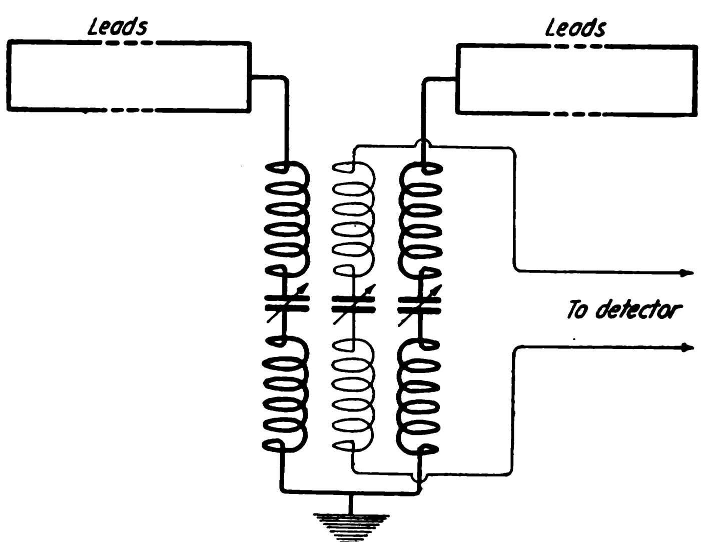


Figure 13—Circuits of an experiment wherein the leads of the Weagant loop antennae were employed as low horizontal aerials, both being coupled to a common detector circuit through a goniometer

increases its capacity to earth increases and at some point becomes sufficient to close the loop.

"As this capacity increases, however, the currents originating in this increased length have various paths in which to flow, one of which includes the receiving apparatus but others are through the capacity to earth between the conductor and the receiving apparatus, and the larger this gets the greater is the proportion of the currents originating in the ends of this aerial, which are diverted and do not flow through the receiving apparatus. This method of considering such an aerial is further supported by the fact that the greater the capacity per unit of length which exists between the conductor and the true underlying earth, the shorter is the maximum length which can be used to advantage. This capacity is a maximum, of course, when the aerial is actually buried in the ground or under water, becoming less when the wire is run on the surface of the earth and still less when the wire is suspended at some height above the earth, tests having shown that wires suspended some 10 feet above ground can be used up to some six miles in length, the signal increasing with length; that a length about one-half of this is effective when the wire is laid on the ground and of approximately 2,500 feet when the wire is placed under brackish water.

"I have also found that as the distance of such an aerial above ground is increased, its action becomes more nearly that of an ordinary antenna, and that therefore on account of its position relative to the incoming signal, it becomes less effective in collecting this signal energy."

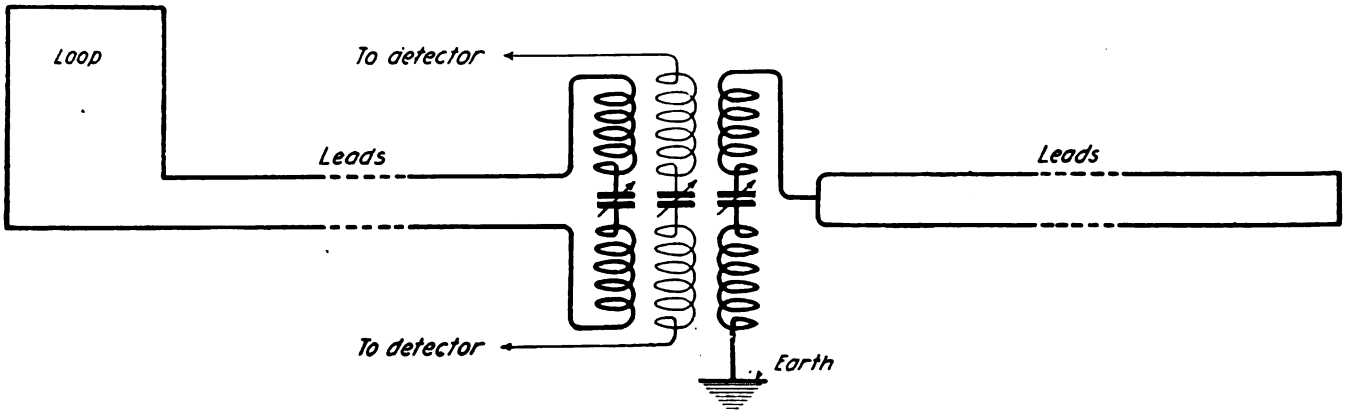


Figure 14—The circuits of an experiment wherein the horizontal leads of one loop were balanced against a second loop used in the regular way but not connected to earth

length to the height is unusually large. It follows that the aerial which is pointed in a direction away from the transmitting station is a much better receiver of the signal energy than the aerial which runs in a direction toward the transmitting station. Both aerials, however, pick up the same amount of static. The two aerials, therefore, may have a very marked difference in their signal to static ratio, and this effect will add to the effect resulting from their phase separation when this separation is small. At times, this constitutes a factor in the results obtained. While figures 11 and 12 show direct coupling at the coil L, any of the well known methods such as electrostatic, inductive or resistance couplings may be employed.

Mr. Weagant finds that this principle operates in all of the arrangements shown in figures 12, 13, 14 and 15. Figure 12 shows the connections used in an experiment in which the loop leads were connected together and each loop converted into an ordinary aerial tuned to earth. In figure 13, the leads were disconnected from the loops and their ends joined, thus making them horizontal aerials tuned to earth. In figure 14, one loop is used in the normal way and balanced against leads of the other loop tuned to earth. In figure 15, one loop is connected in its normal way while the other one is arranged as an earthed aerial. In all methods where an aerial tuned to earth is employed, it was found that the counterpoise aerials gave the best all-around results, although fair results were obtained with all the foregoing arrangements.

In addition to the foregoing connections, other variations in the circuits were also tried.

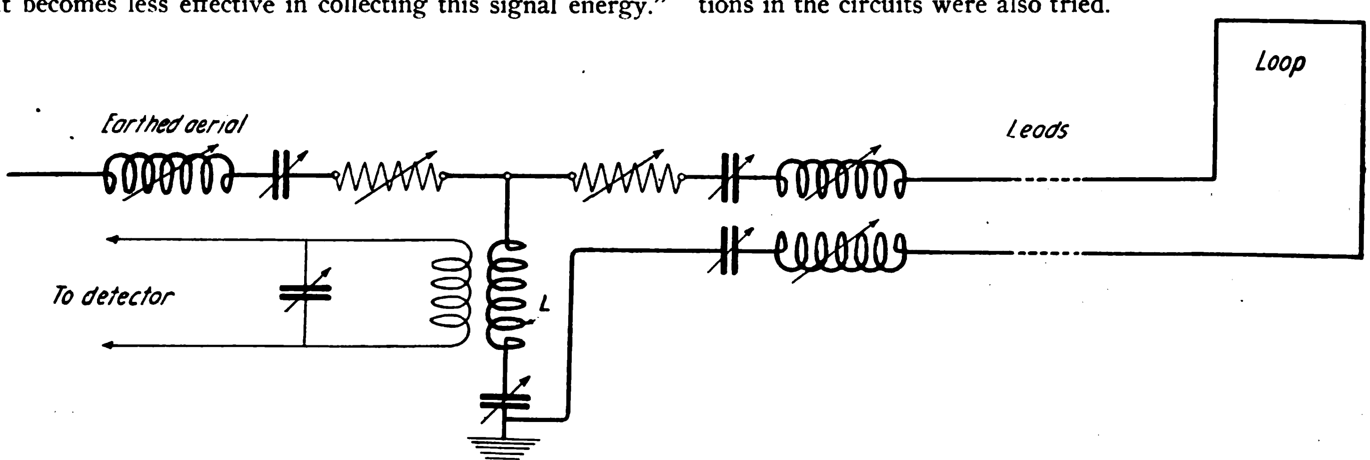


Figure 15—The circuits of an experiment wherein one of the loops in Weagant's system was connected in the regular way and balanced against an aerial tuned to earth

At an early date, at the Marconi station at Belmar, N. J., additional experiments were made by Weagant with the antenna shown in figure 11 and other combinations. It will be noted that the arrangement shown in figure 11 consists of two Marconi aerials of which the ratio of the

ELIMINATION OF INTERFERENCE BY THE WEAGANT SYSTEM

A discovery of vital importance in connection with the looped antenna of the Weagant system was the fact that

it constitutes, as a whole, a uni-directional receiving antenna; that is, signals arriving from one end of the loop can be tuned in, while an interfering signal from the opposite end can, by proper phase adjustments, be tuned out.

When the looped antenna system is adjusted to annul static of the "grinders" type, the system has a reception curve of the form shown in figure 16; its equation, is, v = V cosine², while that of the single loop is the cosine curve. The directional effect in this case is materially greater than with the single loop.

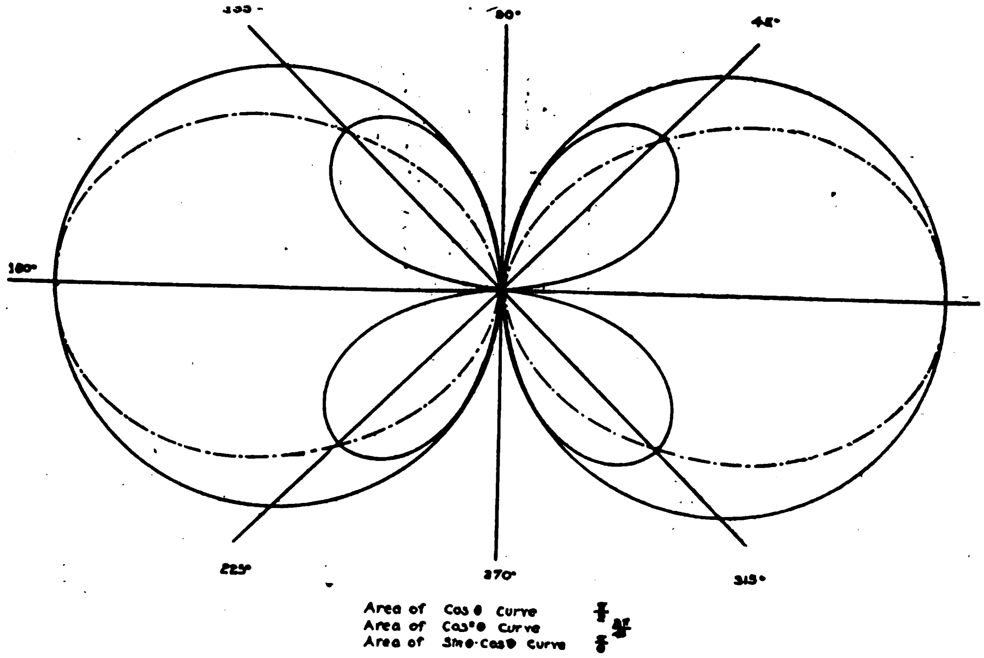


Figure 16—Reception curve of the Weagant system utilizing two-loop antennae

By shifting the phases of the currents in the loop antennae, the reception curve becomes that of figure 17. Between $\theta = 0$ and $\theta = \Pi$, the curve is a cosine² curve while between the angles $\theta = \Pi$ and $\theta = 2\,\Pi$ the curve is a sine-cosine curve, when the loops are ¼ wave length apart. This curve indicates maximum reception in one direction and zero reception in the opposite direction, with a considerable reduction of signals in the third and fourth quadrants. The line of zero reception can be swung at will through the third and fourth quadrants by alteration of the phases of the currents in the two loops, so that interference from any station arriving in either quadrant can be annulled, while reception is maintained from signals arriving in the first and second quadrants.

Mr. Weagant pointed out that advantage can be taken of this property to eliminate static interference if the static waves happen to come from a direction other than that from which the signal arrives. This is of considerable help when a thunderstorm is gathering in the vicinity of the station. Although the most effective spacing of the loop to obtain this uni-directional characteristic is one-quarter length, a general order of the result is obtainable with any spacing between the loops. The process of adjustment for obtaining one-way reception is quoted from Mr. Weagant's paper as follows:

"Suppose that the two loops of the system are one-quarter wave length apart and that the desired signal arrives from right to left; then the currents in the left-hand loop are 90 degrees behind those of the right-hand loop, if the circuits are accurately tuned, and they will add in quadrature. Next, suppose a signal arrives from left to right; then the currents due to this signal in the left-hand loop are 90 degrees ahead of those in the right-hand loop and therefore also combine in quadrature. Then currents due to both signals exist in the common receiving circuit.

"Suppose now, the phases of all currents in the left-hand loop are shifted forward 90 degrees; then the currents due to the desired signal in this loop are shifted around until they are in phase with those from the right-hand loop, while the phase of the currents due to the interfering signal in this loop, and which were previously 90 degrees ahead of those due to the right-hand loop, are now 180 degrees ahead of those in the right-hand loop, so that they oppose and neutralize. Because of the unusual characteristics of the aerial used, this shift in phase is readily accomplished by a small adjustment of the condenser in the loop circuit. If the interfering signal is not in line the right amount of phase shifting can be made to take care of it, and this general order of result is obtainable to some extent with any spacing between the loops, although one-quarter wave length is best. The reception of Carnarvon's signal, 14,200 meters, through the powerful interference of the 200 kw. Alexanderson alternator at New Brunswick, only 25 miles away, working at 13,600 meters, has been an everyday performance of the system, while at the same time preserving a good static balance. All forms of the arrangement described have capabilities of reception through interference, these capabilities varying with the type of aerial employed, the loop aerials and the horizontal aerials giving similar curves."

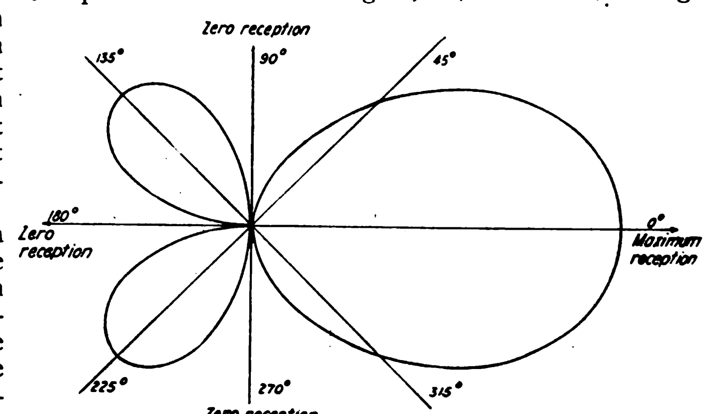


Figure 17—Reception curve of the Weagant system showing the uni-directional characteristic which may be obtained by proper adjustment of the phases of the currents in one loop. Maximum reception is obtained in directions extending through part of the first and second quadrants and minimum reception in the third and fourth quadrants. The line of zero reception may be swung through the third and fourth quadrants at will, by proper phase shifting

(*To be continued*)

My Experiences in the War

Second Instalment of the Personal Narrative of a Pioneer in Aircraft Wireless Who Was Wounded and Captured in the Attempt to Stop the Hun Invasion

By Captain Gordon Adams
South Lancashire Regiment

(*Continued from the February Issue*)

IN addition to wireless telegraphy, the experimental flight dealt with photography, signaling, bomb sights and instruments. Besides wireless as a means of communicating with the ground other methods of signaling were experimented with. The earliest and simplest method of communicating was by means of dropping written messages in weighted bags. Fairly successful results were obtained with a powerful searchlight fitted in front of the nacelle of a "pusher" type machine. Transmitting messages in Morse by means of releasing from a box large and small amounts of soot or color to represent dashes and dots, did not prove a success.

In addition to my other work I was given the job of producing an equation for determining the trajectory of an aerial bomb; if one takes into account the varying resistance of the air due to its change in density at different altitudes, and the effect produced by the state of the barometer, the resultant final equation becomes very complex. Numerical values of coefficients of resistance depending on the shape of the bomb had to be obtained experimentally by dropping a selection of bombs from captive balloons and timing their descent to the ground. This part of the work I did not care much for as I know of no more unpleasant sensation than that which is experienced in a captive spherical balloon on a gusty day.

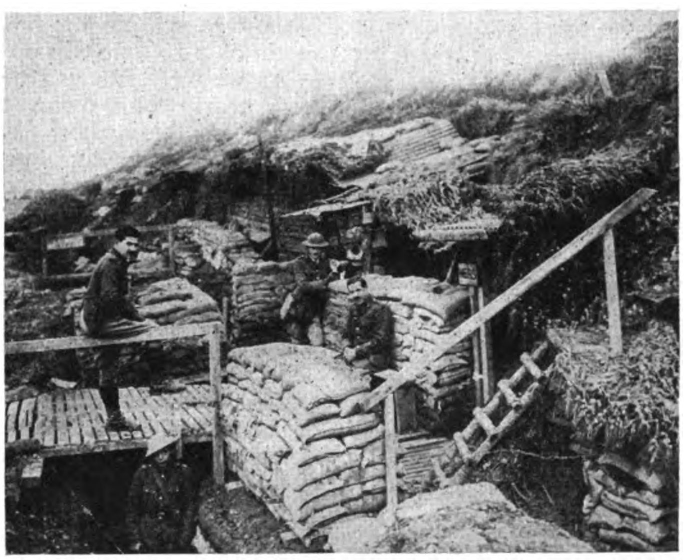


Photo: Press Ill. Svce.

This skilfully engineered dug-out and the almost luxurious mess hall for officers forms a marked contrast to the early days of the war which Captain Adams describes, when he lived in a shallow field trench and was without food for 48 hours

In conjunction with my work on bomb trajectories, I designed a bomb sight which, in addition to its ordinary functions, made allowance for the drift of the machine caused by side winds. Many details have since been greatly improved in bombing range finders, and for that reason a description of my early sight might be of interest. The backsight and foresight were carried on a brass rod about a foot long. The rear end of this rod was attached to another rod mounted horizontally between to fixed uprights, with the rod left free to revolve about its longitudinal axis. The foresight end of the sight rod was attached by a sliding device to a bar which stretched transversely across a ring which was free to turn inside an outer ring. These two rings with the transverse bar could be moved fore and aft on slides, varying with them the foresight.

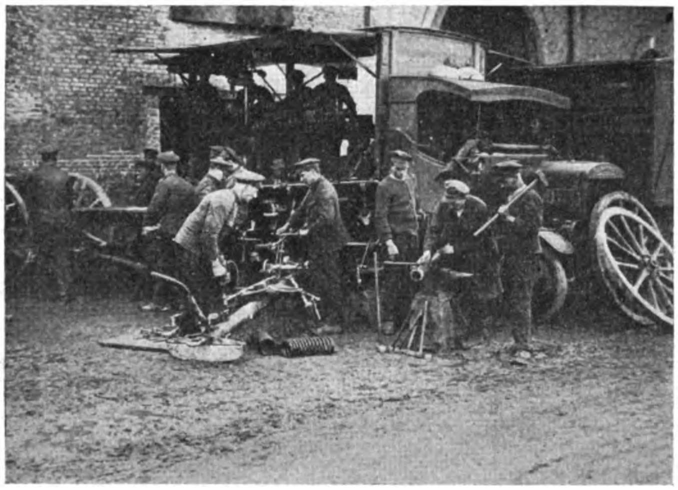
The method of setting the sight was as follows: First, ignoring the wind, the transverse bar was placed in a fore and aft position and the foresight brought to its centre, by means of the sliding attachment. Then the whole system of rings, transverse bar and foresight were moved forward on the slides according to a scale graduated for different heights. The foresight was then moved along the transverse bar to allow for the strength of the wind, and finally the transverse bar and inner ring were rotated inside the outer ring to allow for the direction of the wind.

The wind scale was constructed on the principle of the slide rule, the two factors being time of fall of the bomb and strength of the wind.

While at Farnborough, I acquired the greatest admiration for the test pilots of the Royal Aircraft Factory, whose job it was to test any new and untried type of machine. As aviation then was in its infancy and a great deal about stability had yet to be discovered, their work was attended by the greatest risks. One of these pilots—a close personal friend of mine appeared to have nerves of steel. I have known him to crash and completely pulverize a machine, and then, when he had scarcely cleared out from under the wreckage, to take up another machine straight away, without even waiting to smoke a cigarette. His method was effective, but a trifle rough. I recall that on one occasion when flying at Farnborough his engine gave out and he was just unable to reach the aerodrome; in fact, in his glide he hit the top of a tree in the grounds of a neighboring convent. I am told that the language to which he gave tongue very nearly resulted in the departure of the Sisters of the convent to a part of the country far removed from flying grounds. Leaving aside the potential value of so ready a vocabulary, I am sure that this pilot would have done great things in the war had he not had the misfortune to be taken prisoner in the very early days.

It has often struck me as remarkable how in some cases the most trivial mishap will end fatally for the pilot, while in other cases the most fearsome looking crash will result in nothing more serious than a few bruises. I saw, in the spring of 1914, a collision between two machines at a height of about 1,000 feet, resulting in both machines nose diving straight to the earth. Although the pilot of one machine was killed the aviator in the other was not even temporarily knocked out; in fact when I got to the spot I found him walking about. The subject of accidents brings to mind a somewhat extraordinary coincidence.

On July 20, 1913—I was then at the Central Flying School taking the military aviation course—a discussion of flying accidents came up during the course of a conversation which I was holding with my most intimate friend in the R. F. C. He remarked to me, I recall distinctly, that he wondered if he and I would both be alive



British Official Photo

Mobile workshops followed the British army into the field at an early date, enabling repairs and re-assembling of all equipment to be done without loss of valuable time

in a year's time. On July 20, 1914—a year, to the day—he was killed in a Henri Farman biplane at Gosport.

About two months before the declaration of war the entire military wing of the R. F. C. concentrated on Salisbury Plain. The wing then consisted of 9 airplane squadrons, either complete or in the process of formation, the officer personnel being about 120. It seems to me to be one of the greatest achievements of the war, that from this nucleus was created a flying service numbering its officers and airplanes by tens of thousands.

The work of the R. A. F., as the air service was known when the R. N. A. S. and R. F. C. amalgamated, is even more remarkable when one realizes the meager supply of equipment available at the start and the total lack of any experience with the airplane as an implement of war.

It is interesting to note that at the commencement of hostilities "stunting," particularly "looping," was a court martial offence. Furthermore, in August, 1914, nothing had been done in the way of aerial gunnery. A month before the war I returned to my regiment and tried to change over to the Naval Wing of the R. F. C., which at that time was in the process of being very considerably enlarged. I hoped in that way I should see more of aviation as a whole and have a wider scope. However, I was doomed to disappointment, just as I had got everything practically fixed up. The war broke suddenly and in answer to telegrams which I hurriedly sent to London I was told that for the present all officers would have to remain where they were.

Accordingly I sailed for France with my regiment on August 13, 1914.

* * *

Before proceeding with the narrative which begins with our departure for France, it would be well to give a brief outline of the composition and organization of the British Army at the outbreak of the war. Each infantry regiment consisted of a depot, 2 regular Battalions, 1 or 2 Special Reserve Battalions, and 2 to 4 Territorial Battalions. Of the two Regular Battalions one was always stationed at home and the other abroad, generally in India. The work of the Special Reserve was to supply reinforcements, while the primary duty of the Territorials was home defence. The Depot unit collected recruits and put them through their initial training. When they finished their training, they were sent to the home battalion and generally remained in that unit for another two years. At the end of that time they were drafted to India, where they saw several years service, finally returning home to go into the Reserve or to complete their service with the home battalion.

With the declaration of war the reserves were called up in sufficient numbers to complete the establishment of the home battalions. It was these home battalions which constituted the British Expeditionary Force. When mobilized for war these men had generally averaged about 7 years service with the colors. The officer personnel was brought up to establishment by officers drawn from the Special Reserve. The British Expeditionary Force consisted of 6 infantry divisions and 1 cavalry division. Artillery, Engineers, and other special auxiliary troops were included in the Infantry Division. This was the force of trained fighters which William Hohenzollern was pleased to term the "contemptible little British Army."

The B. E. F. immediately started mobilization on the declaration of war on August 4, 1914; nine days later we embarked at Southampton. At that time I was senior subaltern of my battalion. The secrecy with which we left England has since struck everyone as very marvelous. I believe I am right in saying that the only person who witnessed our departure was a diminutive boy scout who had brought a message to the quay for the colonel. Daybreak on the morning of August 14 saw us anchored off Havre waiting for the tide. At noon we started off again on a 70 mile trip up the Seine.

As we were entering the mouth of the river we were very nearly sunk, owing to one of the men accidentally letting go the anchor. We pulled up with a jerk and were very nearly run down by another and much larger transport which was immediately in our wake. The whole way up the Seine we were greeted by crowds of cheering Frenchman, and finally, about 7 in the evening, we disembarked at Rouen and went into camp about 3 miles outside the town. The second morning following, at 6 a. m., we left Rouen by a train which took us to a place called Aymeries. I was fortunate in being billetted with the right half battalion, for we put up in a very nice old-fashioned farm house, the owner of which provided a most excellent dinner; many toasts were proposed and some stirring speeches made. It was a night to live in memory.

Early the next morning we marched to a small village

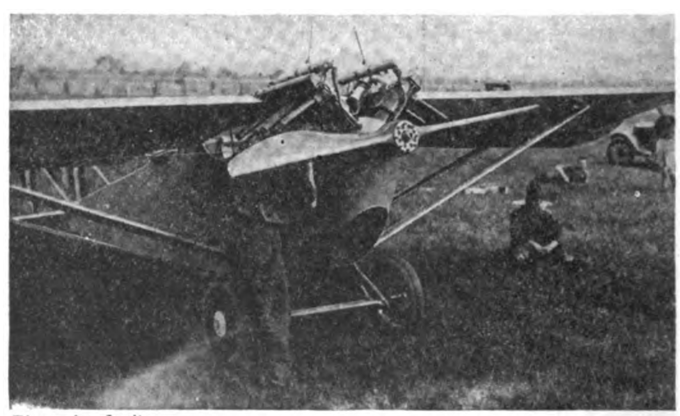


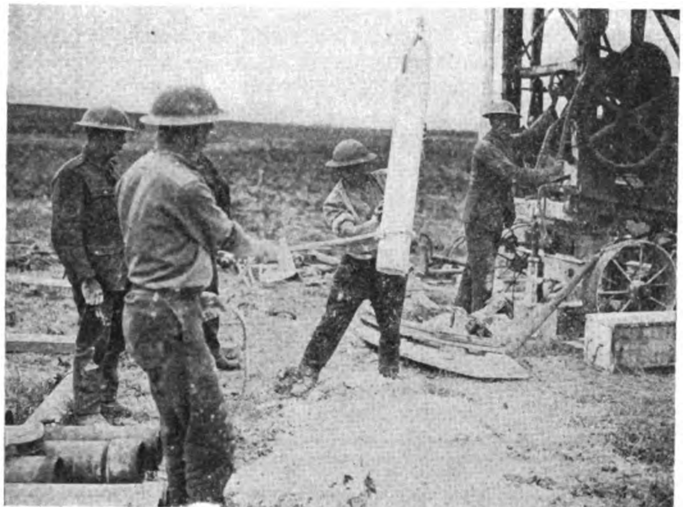
Photo by Int'l

This Loening monoplane, equipped with a 300 horsepower Hispano-Suiza motor, made a speed of 145 miles per hour recently and attained a height of 25,000 feet in 43 minutes. Its monoplane predecessors described in this article had no elements of safety and very uncertain control

called Marbaix. Here I recall seeing a veteran of the Franco-Prussian war of 1870 who had had the whole of his nose, eyes and forehead blown away, but appeared to be perfectly fit and happy. He wore a French Legion of Honor. My billet at Marbaix was comfortable but I could have wished for something better in the way of atmosphere. The building was a cheese factory.

We stayed in Marbaix until the 20th, while the rest

of the troops came up. The weather was glorious and I was quite beginning to enjoy war. With the arrival of our remaining units we marched on to a large town called Avesnes where we were given a tremendous reception. The mayor met the General at the outskirts of the city, and drank champagne with him at the head of the column. As we continued our march through the town the ladies



British Official Photo

From the day of the outbreak of hostilities the water supply was always a problem. The illustration shows a detail from Britain's "contemptible little army" drilling a well

showered tens of thousands of flowers upon us. It was vastly amusing to see elderly and very dignified officers riding along profusely bedecked with floral tribute that clung to all parts of their anatomy, including neck and ears. The night was spent at St. Hilaire and the march continued at 4, the next morning. That day we covered a very long distance over French cobbled roads and in stifling heat, and arrived in the evening at a town called Feignies. Another long march the next day landed us at Frameries. It was here that we first heard the enemy's fire and saw a few German prisoners being brought in, captured by our cavalry screen.

That night I spent guarding divisional headquarters.

Early the next morning we again marched off—this time, only a few miles—to be rebilletted in a village called Ciphy, a short distance from Frameries. No sooner had we allotted the men to their billets, however, than the order came to "fall in." Rumor had it that we were going to dig some trenches in the neighborhood. But on marching over the crest of a small hill we found ourselves about 2 miles from Mons and virtually in the midst of a battle. We hastily deployed and as rapidly as possible dug some small, field trenches.

About 4 o'clock the enemy started shelling our position, and kept the fire up until nightfall. Our own guns were barking a reply to the enemy's fire from our immediate rear. During the evening I remember sharing my last tin of bully beef with a brother officer. It was the last food I had for 48 hours.

When darkness fell the surrounding country presented a most lurid picture. Every building of any size at all was in flames. Immediately in front of us was a burning church, but all the fire and smoke seemed to be confined to the interior of the building, the only thing that showed that it was on fire was the fact that the spire was glitteringly white hot. I slept something less than an hour and a half during the night.

An hour before dawn, the order was passed down the line in a whisper to stand to. Everything was deathly still. Gradually, the faintest glimmer of dawn appeared, and I could dimly discern about 400 yards to our front a line of ghostlike figures moving about. I whispered to my men to fix their sights at 400 yards. It got lighter. The figures appeared to have approached a bit nearer. Still I held my fire and readjusted the men's sights. Nearer and nearer they seemed to come; the suppressed excitement was intense. Then came the moment when I thought the time ripe to open fire. Peering through the half-light, objects somehow seemed suddenly to take more definite form. My row of supposed Germans was a row of tall thistles waving about in the wind!

With sunrise, the enemy resumed his shelling, and about 9 o'clock an infantry mass attack was launched against us. Numerically, the German strength was six men to our one. I made a hasty estimate of the situation. Our position was roughly as follows: A and B companies were on the right, C and D companies on the left, but pushed forward about 100 yards to the crest of a small rise in the ground. My company was B.

Companies C and D took the brunt of the attack when it came, swiftly and viciously. They put up a very gallant resistance but were driven out of their positions with the bayonet. Through this success, the Germans were now occupying the positions of C and D companies, only 100 yards from companies A and B. Company A was ordered to retire after the remnants of C and D had got back, and my company was left to hold the Germans until the first company had completed its retirement.

When it came my company's turn to retire we had nobody to support us with a covering fire. In order to get back to the rest of the battalion we had to traverse some 600 yards of absolutely open country, flat as a billiard table and in full view of the enemy. It was an uncomfortable prospect, but in covering that ground I received one of the greatest surprises of my life. We had heard much about the efficiency of the German war machine, and we naturally expected that they would be able to shoot with tolerable accuracy. Yet during the whole of that 600 yards retirement the enemy were shooting at us with rifles and scores of machine guns, but their shooting was so execrable that out of a target consisting of 240 men they only succeeded in hitting four!

As we fell back it was plainly evident that it was quite hopeless to entertain any idea of defeating the Hun outright, owing to his overwhelming majority in numbers; our instructions were to continue retiring, holding on to successive positions until the last moment and contesting every inch of the German advance. Thus we were to gain

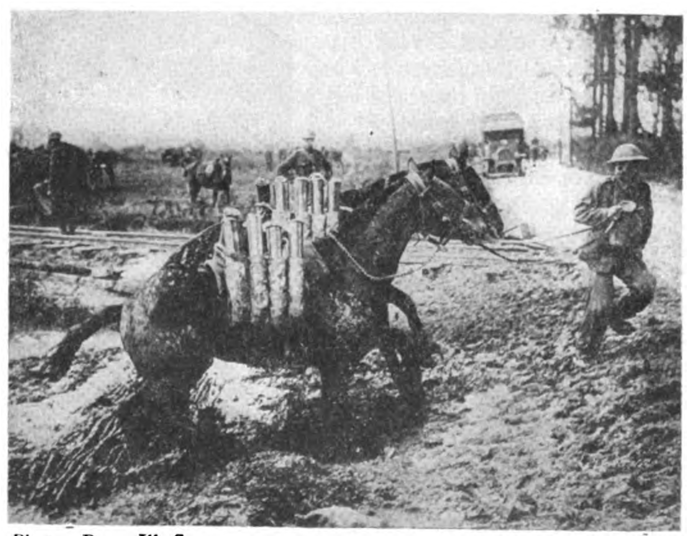


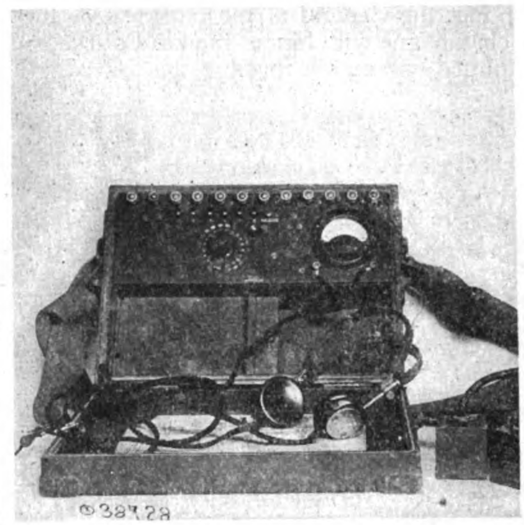
Photo: Press Ill. Svce.

Falling back before the first onslaught of the Germans, as described by the author, was a process made increasingly difficult by the sticky, clinging mud which impeded progress everywhere

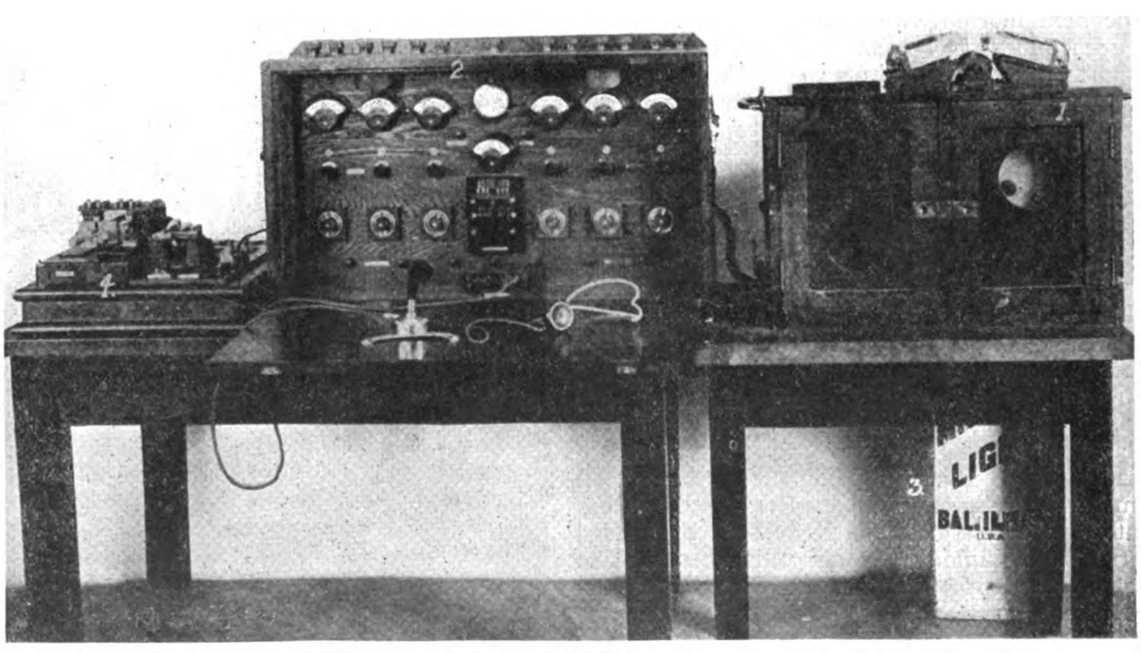
time for reinforcements to arrive. We took up position after position. Halte, Blaigemes, Beaudigines and other villages were successfully evacuated. All this time the weather was intensely hot and we had no food and practically no sleep. During 112 hours I had 6 hours sleep.

(Continued on page 26)

To the right: A signal Corps official photograph of the light microphone set used in trench eavesdropping operations which have been so widely discussed by home-coming soldiers. The apparatus can be used for either local underground or surface listening and the observer may be placed any desired distance from the point of detection



To the left: A photograph taken in St. Laurent, France, on August 20th last, showing members of the 102nd Field Signal Bn. (formerly the 1st Bn. of the New York National Guard), laying wires from General O'Ryan's dugout. This huge dugout was divided into two rooms, one for General O'Ryan and staff of the 27th Division, and the other for telegraph tables and telephone switchboards. The structure, the entrance to which has a camouflage screen, was built by the 102nd Engineers, formerly the 22nd Regt., N. G. N. Y., commanded by Brigadier General Cornelius Vanderbilt, one of America's most noted millionaires.



A complete view of the American sound ranging set used for locating enemy obscured guns and batteries; it was by means of this apparatus that one of the big Hun guns which was shelling Paris was located

Photos by Signal Corps, U. S. A.

Wireless Communication with the Far East*

By W. A. Winterbottom

Traffic Manager, Marconi Wireless Telegraph Co., of America

FEW subjects today are of greater interest or importance to the American business man than improved and largely increased facilities for international communication. Without the opportunity for cheap and rapid communication between nations, commercial and social progress is seriously retarded, if not made impossible.

The Far East has long been in close telegraphic touch with Great Britain, and the channels of communication today between continental Europe and the Far East are far more numerous than those we possess. Less than twenty years ago our telegrams for the Far East were sent across the Atlantic to Great Britain, and thence forwarded either across northern Russia or through the Mediterranean on the way to Japan and China. The rate per word was very high indeed, much as $3.00 per word from New York City to Japan. Japan at that time could hardly have been further from the United States.

Then the Commercial Cable Company, with farsighted vision, laid a cable from San Francisco to the Far East, connecting up the Pacific Islands on the way. Our Far Eastern commerce at that time was quite small; it required considerable courage and faith in the future to literally sink from ten to fifteen million dollars in the Pacific Ocean.

The Pacific Cable brought the Far East much nearer to us than ever before; for in the telegraph fraternity, countries are near or distant according to the number of transmission points intervening.

Prior to the advent of the Pacific Cable at least twenty transmissions were necessary to send a message from New York through Europe to the Far East, which did not help to make cipher messages more readable.

The Pacific Cable reduced the number of transmissions to three or four. If we could still further reduce these retransmissions, to that degree would we bring the United States and the Far East closer together.

This problem has at last been solved by wireless telegraphy, and direct and instantaneous reliable communication by radio is now possible between the Far East and the United States. It is only a few months ago that one of Japan's leading statesmen, familiar with the progress of long distance wireless communication, stated in a public address "The Pacific Ocean, which has so long widely separated our two countries, is now no broader than a river." Japan could hardly be nearer.

The fascinating story of long distance commercial wireless has unfortunately been interrupted by the great war. The military and naval authorities have taken over temporarily all wireless services for uses much more important than the requirements of commerce. The United States Navy has found the high power stations of the Marconi Company extremely valuable for European communications and a few weeks ago submitted a bill to Congress providing for the permanent ownership of all wireless stations in this country. To have so monopolized high power radio communication would, I feel sure, have been a serious loss to the commercial world, but I am glad to say that the Congressional Committee unanimously voted against the Government ownership plan.

When peace is officially consummated and we are permitted to operate our stations commercially, a low priced, rapid and reliable means of communication will be available for use to Great Britain and the Continent, Scandinavia and Russia, the Far East and Australia, and a little later Argentina, Brazil and other South American countries, Mexico and the West Indies. It is a large program, but the greater part of it is already completed.

The first, and perhaps most interesting, long distance commercial wireless service was inaugurated in 1912—only seven years ago—between Great Britain and Nova Scotia. It is a little out of date now in its equipment, but it continues to render a satisfactory service between Great Britain and Canada, and at the present time some of our American newspapers are receiving considerable quantities of European news over this route in competition with the cable services.

Other and much larger wireless stations erected by the Marconi Company are located in New Jersey, Massachusetts, California and Hawaii. Another powerful station is now under construction just outside Buenos Aires.

The New Jersey stations will communicate directly with Great Britain and the Continent. The Massachusetts stations will communicate directly with Norway for messages to and from that country, Sweden, Denmark and Russia. The complementary stations in Europe are completed, and are only awaiting the proclamation of peace to change from their military character to that for which they were primarily designed.

The stations in California have already rendered excellent service to Hawaii and the Far East, and will do so again as soon as they are released to us.

Our Navy Department has been making very extensive use of the Marconi high power stations for communications with Europe, working at all times directly with stations in England, France and Italy.

In view of the fact that some people today doubt the reliability of radio communication as compared with submarine cable communication, it is interesting to quote the words of Commander S. C. Hooper—head of technical bureau of the United States Naval Radio Service—who recently testified before the Congressional Committee just referred to. Speaking of the Marconi high power stations and the service they have rendered the country during the past eighteen months, he said: "They are the stations which will compete with the cables for the handling of messages overseas, and I am not making any new prophesy when I state that the competition will be keen. Since the war has been on we have established reliable communication across the ocean and we never miss a message from the other side."

You will recall that the cable service to which the Commander compared the radio service, is over fifty years old in development and experience, while we are only seven. Further evidence of the position now occupied by wireless is the recent order of Mr. Burleson directing that all Government messages for Europe, except those for some special reason routed via cable, should be forwarded by wireless. Since important and confidential Government communications may now be handled by wireless, we may rest assured that a new era of communication is at hand, the possibilities of which we can only conjecture.

And now to mention the service to the Far East.

In 1914 the Marconi Company completed high power stations near San Francisco and Honolulu to compete with

*An address delivered before the Japan Society in New York.

the single Pacific cable, and offered its new service to the public. From the beginning, it was extremely popular with the Hawaiian business men, for they now had competition, and competition in oversea telegraph service is a fine thing. It usually results in cheaper rates, a more expeditious service, and greater satisfaction to the public. For almost fifteen years the citizens of Hawaii were required to pay for every word sent to San Francisco—it mattered not whether it was plain language or code, important or otherwise—at the rate of 35 cents per word. This rate was never changed, and the number of telegraphic communications between Hawaii and the mainland, and vice versa, was very small indeed. The Marconi service opened at 25 cents per word, a reduction of 10 cents per word, and further, introduced the popular night and week-end letters to the Hawaiians at a rate of approximately 8 cents per word.

Reflect for a moment. Rates reduced from 35 cents to 25 cents and 8 cents per word. No wonder the Marconi Company has so many friends and supporters in Hawaii, that small but important mid-Pacific outpost whose Chamber of Commerce sent a representative to Washington to raise its official voice in vigorous protest at the proposal for Government ownership of all wireless services. The business men of Hawaii have had a practical demonstration of the reliability and rapidity of commercial wireless, and are urging its early resumption by the Marconi Company.

Suffice to say, that within two months the submarine cable tariff which had stood so long was lowered to the level of the new wireless tariff, and it is generally acknowledged that within two or three years thereafter the number of telegraphic communiations to and from Hawaii was increased fourfold.

The trans-Pacific wireless service was not planned to stop at Hawaii. The Far East, and even Australia, was our goal. Our Hawaiian station had been built (at a cost of approximately $2,000,000) in two distinct sections, one to work to California, the other to work with Japan, both sections to work simultaneously. But the war again interfered. The Japanese station built at the same time was taken over by its Navy Department (for Japan too was at war) and it was not until 1916 that the station was released to commercial operation nine hours per day. Nine hours per day is not a very satisfactory way of conducting a telegraph service, but it was the best we could get until peace came, when we could expect the full use of the station.

In 1916, therefore, I went to Hawaii to supervise the inauguration of the first wireless service conducted between the United States and Japan. The usual messages of felicitation were exchanged between President Wilson and the Emperor of Japan, Ambassadors and other notables, and then we settled down to commercial business.

The cable rate from San Francisco to Japan, which had prevailed for years, was $1.21 per word, with no deferred or other cheaper service. The Marconi service opened at 80 cents per word for urgent communications, or a reduction of 41 cents per word, and also offered for the first time a non-urgent service at 40 cents per word, a reduction of 81 cents per word.

The service immediately became so popular and satisfactory that some means had to be adopted to curtail the volume of business offered for transmission, as it must not be forgotten that we were restricted to 9 hours per day and that was divided into three periods. It was therefore decided to confine the service to the city of San Francisco, which is perhaps our second largest center of Far Eastern trade.

Although it was expected to utilize the Hawaiian station as a necessary relay point for Japanese messages, it was soon discovered that practically all messages transmitted from the Japanese station were received with equal facility in California, and it was only occasionally that the assistance of the intermediate station in Hawaii was required. Further recent improvements in the radio art have assured the regularity of this direct Japan-United States wireless service.

I might add that, while I was in San Francisco, several of the large Japanese steamship companies and export houses expressed their amazement at the high grade service we rendered. The accuracy of the service, due to the elimination of relay stations, was most gratifying and the economy was of course fully appreciated. The service continued to increase in efficiency and volume of traffic until April 7, 1917—the great day in our history on which war was declared upon Germany—when the Navy Department commandeered our stations and has not yet permitted us to resume commercial operations. I understand that since the armistice the Navy Department has been offering a limited public wireless service from San Francisco.

And so science has at last brought the United States and Japan very close indeed, and with the advent of freer and cheaper communication, we may confidently look forward to a constructive age of peace, goodwill and a better understanding between the once widely separated peoples of the world.

My Experiences in the War

(Continued from page 23)

Among the troops falling back before the German onslaught was a celebrated British cavalry regiment, of which an amusing incident is told. On one occasion, thinking that they were at last free from the enemy for a few moments, they repaired to a neighboring stream and proceeded to bathe. While engaged in this refreshing recreation the alarm was sounded. A regiment of German Uhlans was approaching. Not waiting to dress, our men seized their sabres, mounted their horses and charged—clad simply but tastefully in their birthday suitings. The Germans stopped, amazed, and then beat it for all they were worth. The redoubtable Uhlans were not sufficiently brave to try conclusions with this absolutely unknown and unheard of type of soldier.

The war always held its humorous moments; but these were rare; in the main it was ever a grim business. At about 4 o'clock on August 25th, just as we were approaching the town of Solesmes, the enemy opened heavy shell fire on us from our right flank. The men were in the last stages of exhaustion, but at the sound of fire they immediately seemed to become revitalized. We rapidly took up a position on the top of a hill immediately north of the town. As soon as we were in position there came a temporary lull in the enemy's fire; but only for a few minutes. The Hun guns very shortly reopened with a veritable tornado of shells. For about 3 hours we were subjected to this hail of high explosives. Our reply was a crashing heavy rifle fire on his gun position, and we kept it up until nightfall. When we had expended all our ammunition our instructions were to hold the position at all costs until dark, in order to give the forces behind us time to consolidate their position at Le Cateau, about 6 miles in our rear.

At 8.30 the Colonel gave orders to retire. I had covered about 100 yards and was just congratulating myself in still being alive, when a shell exploded about a yard away and blew my thigh bone to pieces. I went down like a shot rabbit; and where I fell, there I stayed.

(To be continued)

EXPERIMENTERS' WORLD

Experimenters are urged to submit manuscripts covering the design and construction of all types of wireless apparatus for amateur use. Such articles will receive immediate consideration and those published will be paid for at regular space rates. The scope of this department is constantly enlarging

Amateur Transmitting Panel

Improving the Efficiency of a Wireless Station

By A. R. Zahorsky, New York

IT behooves every amateur to prepare for the time when the Government will give out the order to go ahead. The design of the transmitter should be given careful consideration, for whether one is able to transmit signals 1,000 miles, or only 100 miles, with a one kilowatt set, will depend upon the mounting of the component parts, as well as upon the electrical characteristics of the apparatus. The objects of this article are: To set forth methods of eliminating certain factors which tend to reduce the efficiency of a wireless station, and to show drawings of a transmitting set which will help to illustrate the fundamental points of this discussion.

Ground Connection

The ground connection is a vital part of a wireless station. If it is poor, the effectiveness of the system is greatly diminished. The most efficient "ground" to be obtained by the amateur is a connection to the city water mains. The water pipes should not be used if the earth wire measured from the instruments to the water pipe exceeds 30 feet in a horizontal direction. In case it exceeds this length, it is advisable to construct a separate earth plate. The following table gives the resistance of different types of earth connections. The amateur should choose the best suited to his purpose, remembering that grounds of lowest resistance have the highest efficiency.

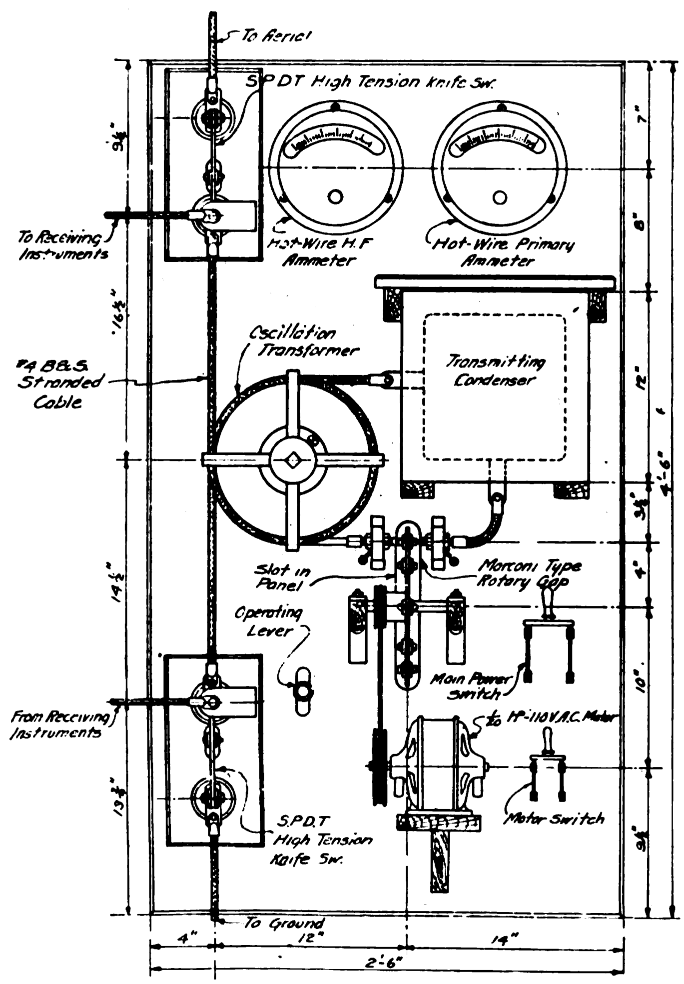


Figure 1—Front view of transmitting panel for an amateur radio station

Resistance of Different Types of Grounds

(1) 10 lb. scrap copper set 6′—0″ deep surrounded with 10 lb. coke ......14.2 ohms
(2) Copper plate 5′ x 3½′ set 4′ deep surrounded with 2′—0″ crushed coke.... 5.6 ohms
(3) 9′ length 1¼″ black iron pipe driven 6 ft. into solid earth .... 25.1 ohms
(4) 12′ length black iron ditto............ 14.8 ohms
(5) Two 9′ lengths ¾″ pipe set 6′ deep in coke. 15.2 ohms
(6) Perforated metal cone 18″ long filled with charcoal buried 6 ft. in 2 ft. of coke. 14.4 ohms
(7) Connection to city water main........ 0.44 ohms
(8) 1″ pipe in deposit of ashes 1 ft. deep.... 26. ohms
(9) 1″ pipe driven in 5′—0″, surrounded with 16 lb. salt mixed with earth, water poured around ....20. ohms
(10) 1″ pipe 5′—0″ long buried 12″ horizontally salted and watered after 4 days ....15. ohms

The resistances given are for rich black soil.

The wire leading from the instrument panel to the ground connection should be short and run as nearly vertical as possible. A No. 4 B & S stranded, rubber covered wire serves the purpose.

Operating Panel

The operating panel, shown in the accompanying figures 1, 2, 3 and 4, may be made of transite asbestos wood, from ½ inch to ¾ inch thick. This is the best kind of material to use, because it is cheaper than slate or marble, more easily worked and is fireproof. However, a panel of neat appearance may be built of 1 inch oak or pine boards and given two coats of floor varnish. The panel is mounted by means of wood screws on two 2″ x 2″ wooden uprights or on iron brackets and braced at a point 15 inches from the wall.

For switching from a transmitting to a receiving position, two single pole double throw high tension knife switches are employed. The blades as shown in the side elevations, figures 2 and 3, are interlocked by means of bell-cranks and levers, and are operated by a lever approximately 2′—7″ from the floor. This places it in a convenient position for a man sitting in a chair.

The wire used for the oscillation transformer shown in figure 3 should be in size no less than No. 4 B & S stranded bare or insulated cable. If none is available, the amateur may build up an equivalent cable by twisting together 27 No. 18 B & S bare wires, or 40 No. 20 B & S wires. The smaller the wires the better will be the conductivity for high frequency currents. The conductor for both primary and secondary of the oscillation transformer are wound on crosses made of pine boards impregnated with paraffine. Both coils are supported so that they

may slide back and forth on a square brass rod set into the front of the panel. The coils are 10 inches in diameter.

The condenser in the primary circuit is built up of ¼ inch glass plates 12 inches square. Half the plates are coated with extra heavy tin foil 9 inches square, applied to both sides. Terminal lags are placed on the case, one on the lower edge, the other on the side. They are preferably made of thin sheet copper. In assembling the condenser a plain glass plate is placed between two coated plates to vary the capacity. This method avoids taking taps from the helix, as is usually done and is simpler.

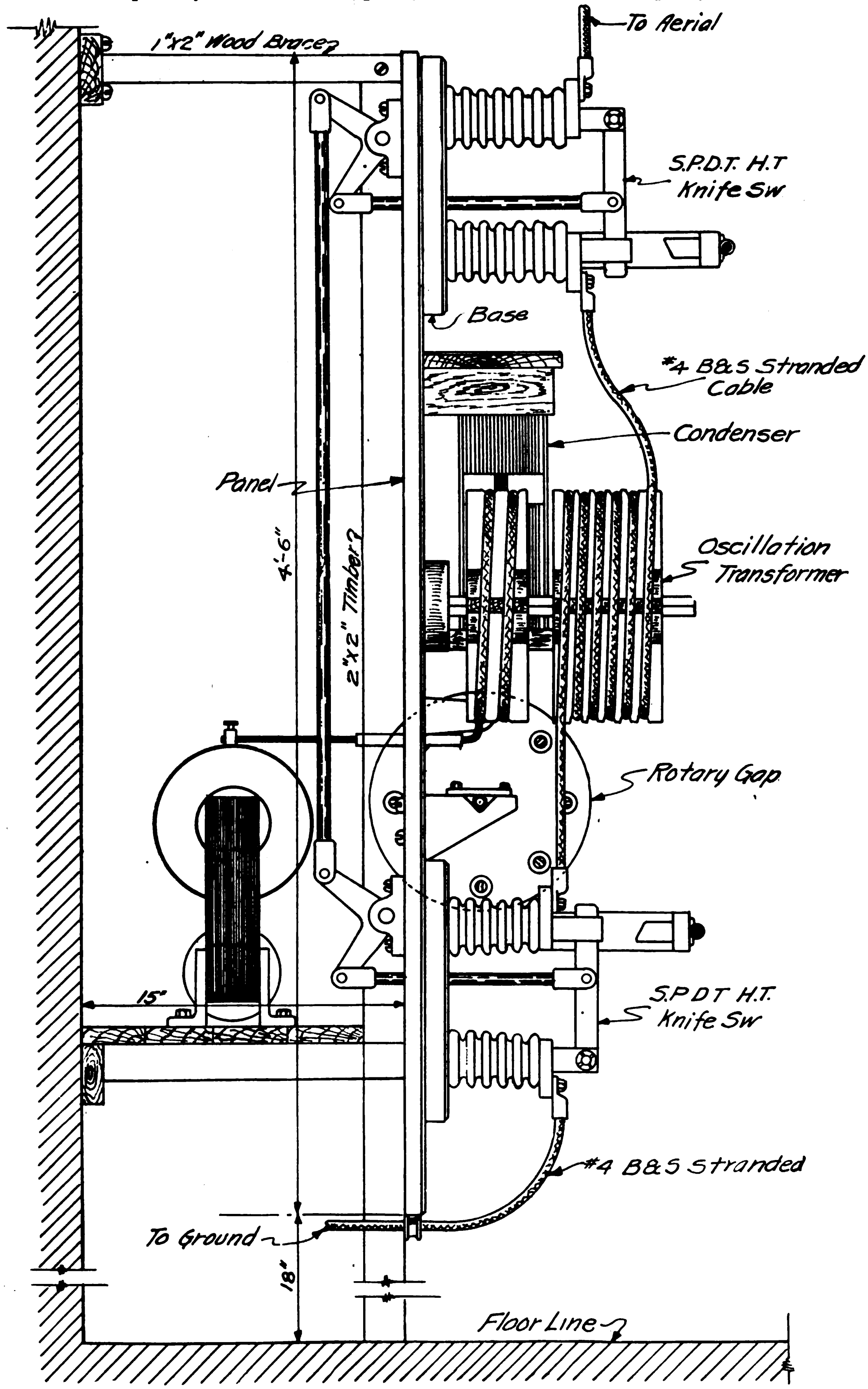


Figure 2—Left end view of transmitting panel showing single pole double throw high tension switches interlocked by means of bell-cranks and levers

The rotary gap is one of the Marconi type of dischargers. The disc is made from a piece of red fibre ¼ inch thick, 10 inches in diameter, impregnated with paraffine.

It has eight 3/8 inch brass studs spaced equally around the circumference and fastened by means of a nut on each side. The nuts are thin, being made by cutting in two with a hack saw a 3/8 inch brass nut. The pulley

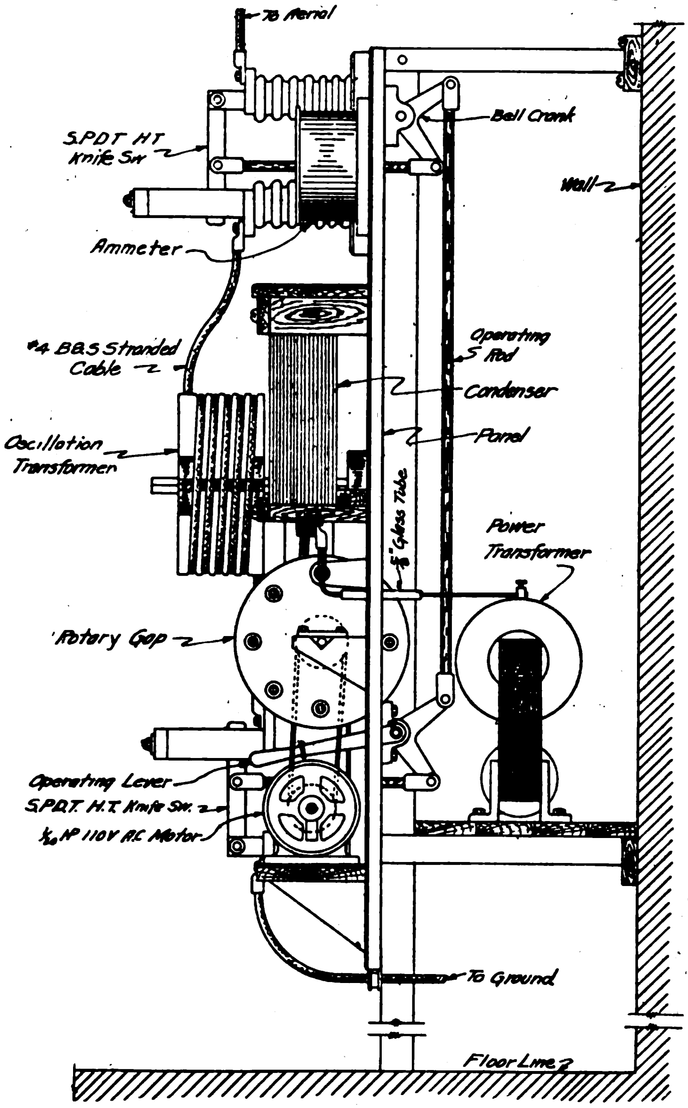


Figure 3—Right end view showing instruments and facilities for their operation

should be about 3 inches in diameter. The disc and pulley are mounted on a piece of 3/8 inch drill-rod 6 inches long, which serves as a shaft. The rotary gap should be driven by a small induction motor and run about 1,800 R. P. M., giving 240 discharges per second. The size of the pulley on the motor depends on the motor speed. A leather belt serves as a driving medium.

The hot-wire ammeter on the left hand side of the panel should have flexible leads with spring clips so that it may be inserted in the aerial circuit when required. The other ammeter is placed permanently in the 110-volt supply line as shown in the wiring diagram, figure 4.

The special features of this transmitter are the short leads in the oscillating circuits and the lack of sharp bends or kinks which would cause leakage at high voltages. All sharp corners on both conductor and insulators should be rounded off with a file. The insulators shown on the high tension knife switches may be porcelain or electrose, or hard wood baked dry and then boiled in paraffine. High voltage insulation is necessary.

It will be noted that there are 5 turns on the secondary of the oscillation transformer. This may have to be modified for aerials of different heights and lengths. The inductance of such a coil is given by Nagaoka's formula:

$$L = \frac{4\pi^2 a^2 n^2}{b} \times K, \text{ cms.}$$

where a = mean radius of coil = 5″ = 12.7 cm.
b = overall length of coil = 3.5″ = 7.89 cm.
n = number of turns = 5
K = a constant depending on the ratio of 2a/b
Obtained from tables by Nagaoka which may be found in Bureau of Standards bulletin No. 74 or bulletin No. 169.

For 2a/b = 3.22, K = .412.

Substituting these values in the preceding formula we obtain, L = 8325 cms.

If we insert this inductance in a "T" aerial 120 feet long and 60 feet in height we obtain a wave length of $\lambda = 203$ meters.

The inductance of the primary coil may be obtained in a similar manner making corrections for the leads from the condenser. If the coil is built to dimensions given in the illustrations, its inductance will be 2084 cms.

The capacity of a condenser used in conjunction with primary inductance L = 2084 cms. is given by,

$$C(\text{mfd}) = \frac{\lambda^2 \text{ (meters)}}{3550 \text{ L (cm)}}$$

If $\lambda = 200$ meters
C = .0054 mfd.

The capacity of a glass plate condenser is given by,

$$C = \frac{n\ K\ A}{4\ \pi\ d} \times 1/9 \times 10^{-5} \text{ mfds.}$$

where n = number of plates required,
K = a constant which for plate glass may be taken as approximately 6.

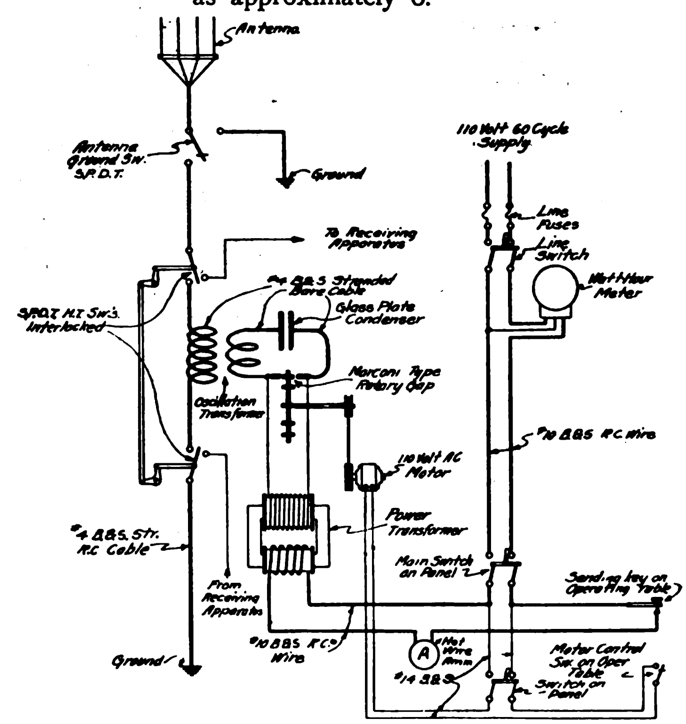


Figure 4—Diagram of connections for the panel set

A = area of the metal foil = 81 sq. in. = 523 sq. cm.
d = thickness of the glass = .25″ = .635 cm.

The number of plates required then is,

$$n = \frac{4\pi\ d\ C}{K\ A} = 12.35.$$

We shall therefore use 13 plates and adjust the capacity by varying the distance between the plates. For the wave length of 250 meters, it will be necessary to use 20 plates.

The diagram, figure 4, does not show protective condensers. A protective unit consists of two 2 microfarad condensers connected in series. The central wire is connected to earth and the two outside wires across the power line close to the meter. A protective spark gap might also be connected across the secondary of the high voltage transformer.

The Up-to-Date Amateur Radio Station

A Station Designed to Permit Reception from all Transmitting Stations Irrespective of Type or Wave Length

By Fearing Pratt, Massachusetts

THE ideal amateur station should be designed to permit reception from all stations, irrespective of the type of transmitter or the wave length employed. The apparatus should be installed to permit the conduct of experiments to determine the best method of connection for a particular set of conditions. Such a station has many possibilities, but it may prove too expensive for some experimenters.

In order that it will not be necessary to duplicate certain parts of the apparatus which are essential to all circuits, the instruments should be assembled so that the connections are easily accessible. The principal receiving set should not, however, suffer any loss of efficiency by complicated connections and combinations of switching devices.

The station I have in mind is composed of three receiving sets with one or more transmitters. Any one of these sets may be installed without interfering with the operation of the others. An amateur is likely to be fully satisfied with his first set, but he will later install additional apparatus from time to time which gives the station the appearance of an experimental laboratory. The main set described in this article has a receiving range of 450-3,000 meters, mounted in a cabinet which is always ready for use. Two additional sets are provided to take care of the upper and lower ranges of wave lengths.

The Aerials

Two aerials are to be used, one for transmitting and the other for receiving. The transmitting aerial should be 60 to 75 feet long and 40 to 60 feet high, with a natural wave length of about 160 meters. A pole erected on the roof directly above the transmitting set permits a short lead-in. Six wires, two feet apart, will give the necessary capacity. This aerial is to be used in receiving stations from 150 to 500 meters and a special transfer switch should therefore be provided.

A larger aerial, running at a right angle to the transmitting aerial, is employed for receiving wave lengths above 400 meters. It should be from 300 to 500 feet long and 50 to 100 feet high, consisting of two wires. The natural wave length should be near to 800 meters. With this aerial it is possible to receive wave lengths down to, say, 450 meters with a series condenser. By appropriate loading inductances, waves up to 12,000 meters may be received.

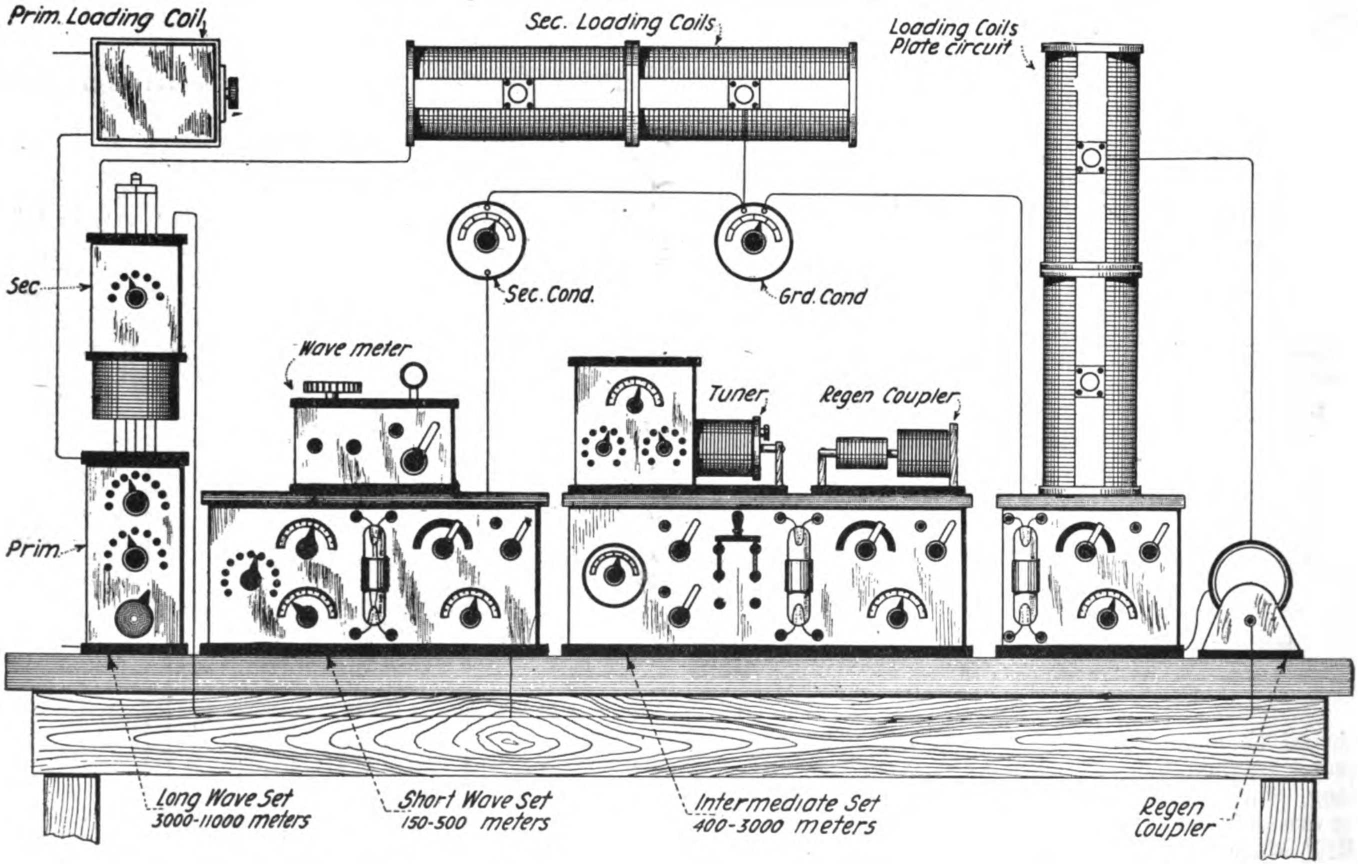


Figure 1—Front view of cabinet with the secondary tuning condenser, vacuum tube controls and the necessary switches mounted in place

The Transmitter

The transmitter consists of a 1 kw. transformer having a secondary voltage of 15,000 volts, connected to a 110 volt, 60 cycle, alternating current circuit. An impedance coil is necessary to regulate the current in the primary circuit. A hot wire ammeter in the primary circuit permits an approximate indication of the power consumed, since the power factor is fairly high and the line voltage remains practically constant. A good key and kick-back preventer are necessary, of course.

A rotary spark gap having studs protruding from the circumference, the studs and outer rim forming one casting, is the most suitable gap for operation with 60 cycle current. This type of rotary gap has two distinct advantages over that type in which the studs are perpendicular to the face of the disc. First, slight variations of the disc

due to warping have no effect on the spark length. (The writer has not yet found any material that will not warp slightly in time.) Second, if the fixed electrodes are brought into contact with the rotating studs while in motion, no damage will be done to the disc. The motor on which the gap is mounted, must have generous bearings. It is much better to use a motor that is a little larger than necessary so that silent operation will be obtained.

A molded high voltage condenser is the best type for amateur use. It will withstand high voltage and have long life. An oscillation transformer of the pancake type is very satisfactory. If the secondary is provided with a rotating contact to permit tuning with the key closed, considerable advantage is gained.

A hot-wire ammeter is accurate enough to measure the antenna current. A thermo couple type of meter may be a little better, but its greater cost may make it prohibitive.

A variometer is also used to tune the plate circuit. A plug is provided for inserting a pair of telephones or coupling the output circuit to the input circuit of another vacuum tube for amplification.

The second, or intermediate wave length set, consists of a series antenna condenser, a coupler, and a secondary circuit with a regenerative coupling. Condensers are used in the secondary and grid circuits. A double throw double pole, and a single throw double pole switch are provided. The first switch marked S-1 shifts the connections from the vacuum tube detector to crystal detectors; the second switch, marked S-2, shifts from a regenerative connection to a simple vacuum tube detector connection. Another single throw single pole switch, marked S-3, connects in an auto transformer so that the tube may be used as an amplifier for either of the other sets. The secondary circuit coils are placed in a cabinet on top of which is mounted the tuning coupler, the regenerative coupler and a series condenser. Most any loose coupler of the proper range will prove satisfactory if the inductance is changed by a multiple point switch. The regenerative control switch is located on the back of the regenerative coupler. On the front of the cabinet are mounted the secondary tuning condenser, vacuum tube controls and the necessary switches.

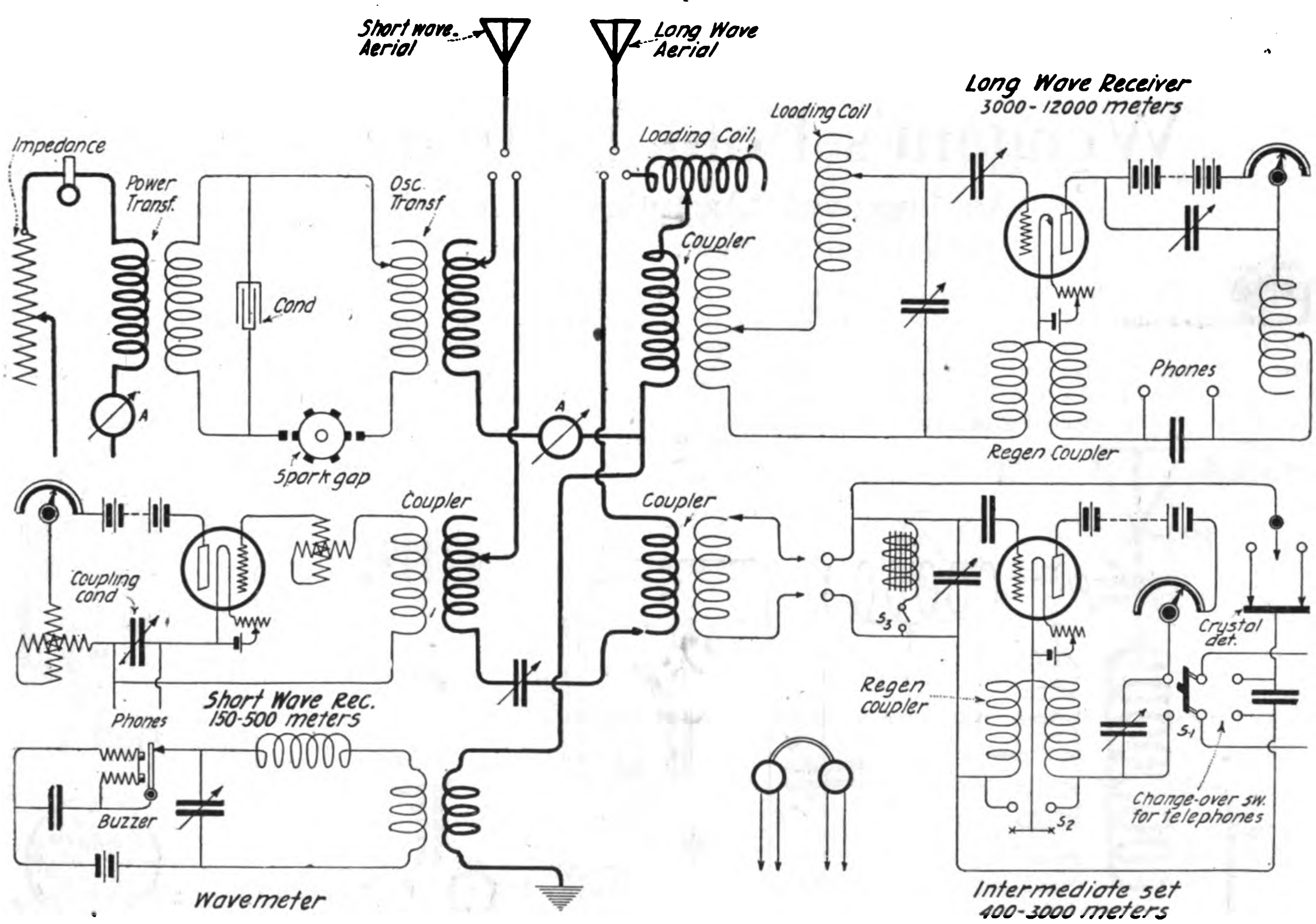


Figure 2—Diagram of connections for the receiving apparatus of an up-to-date amateur radio station

Receiving Sets

The receiving apparatus shown in figures 1 and 2 consists of three complete sets, each being provided with a vacuum tube connected in a regenerative circuit. One set is used for reception from amateur stations and has a range from 150 to 500 meters. It is connected to the transmitting aerial. The second set is the main stand-by set and has a range from 450 to 3,000 meters. The third set is used for receiving from high power stations and has a range from 3,000 to 11,000 meters, or greater.

The first set consists of a small loose coupler with a multiple point switch to vary the antenna inductance. The secondary has but one tap. A variometer is employed as a secondary loading coil; all tuning in the secondary circuit is effected with this instrument. It has been found that a secondary condenser, even if set at zero value, has too great a capacity for short wave lengths.

The third set consists of a 3,000 to 7,500 meter coupler, a regenerative transformer with a vacuum tube and loading coils of sufficient inductance to raise the wave length to 12,000 meters. The coupler is of the multiple point type, with a secondary which moves in a vertical plane. This design is economical in space and, as shown in figure 1, it is desirable that all the nearby inductances shall be perpendicular to each other. Each loading coil is built in two sections, which makes it possible to remove unused units from the circuit.

The primary loading coil is mounted on the wall to the left. The secondary loading coils are shown mounted on the wall over the main set with the secondary and grid condensers below. The tuning switches on the coupler and the secondary tuning condenser must have long handles for operation.

On the right are shown the plate circuit inductances. vacuum tube, and regenerative coupler. The output of this detector circuit may be coupled to the input of the vacuum tube of the principal set, as in the case of the short wave set. Audio frequency amplification is employed. Radio frequency amplifying circuits may be a trifle more sensitive but the slight advantage gained is lost in the complex operations that a radio frequency amplifier introduce. Copper tubing or flexible wire may be used to connect the apparatus as shown in figure 1. The apparatus in the writer's opinion, is arranged for convenience and for maximum efficiency.

A telephone headset of 1,500 ohms each is used for recording the signals. If the experimenter will run a pair of separate cords to each receiver and attach plugs at the ends he can connect one receiver to one of any two sets. This makes it possible to hold communication with another station and at the same time stand-by for a high power station. Both receivers may be plugged in on the same set if desired. Auto transformers may be installed in the long wave and short wave sets so that a detector and two-step amplifier may be added to the circuit.

A wave meter (shown above the short wave tuner) is a very convenient accessory. A small wave meter inductance may be used for tuning the transmitting set and a large inductance for tuning the long wave receiving set. Long distance stations usually have a fixed schedule and fixed wave lengths. This makes it possible to pre-adjust the receiver to the required wave length by the wave meter.

Weagant's Four Element Valve

An Improved Oscillation Valve with Increased Sensitiveness for Detection Purposes

PERMISSION has been granted to present to our readers a description of an improved oscillation valve, one of a series of types developed by Roy A. Weagant. The four element valve illustrated in figure 1, differs from the three element tube described in last month's issue in that it has an unconnected grid element G placed between the filament F and the plate P. The sensitiveness of the tube for detection purposes is thus considerably improved. External to the glass container and parallel with the internal electron stream is the electrostatic control element K, which is generally connected to the high potential terminal of the secondary of the receiving transformer. The immediate effect of inserting the element G is to give the tube a more favorable characteristic for the detection of radio frequency currents by the head telephone.

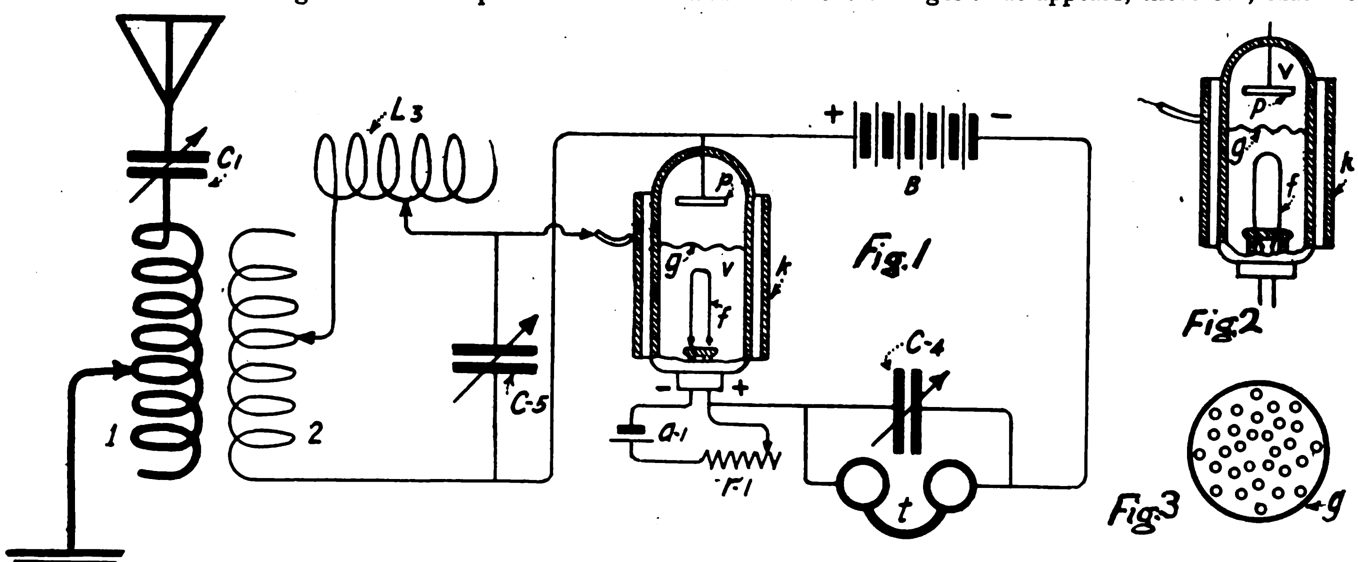


Figure 1—Simple circuit showing hook-up of the Weagant valve. Figure 2—Showing the construction of the valve. Figure 3—One form of the internal element G

According to the inventor, a tube without the element G behaves as follows: If the cathode F and the anode P are spaced far apart, the valve is very sensitive; but because this spacing requires a low potential in the anode circuit, there is a distinct upper limit of signal amplification. On the other hand, if the spacing of the cathode and anode be increased, the plate voltage may be increased with marked amplifications for strong incoming signals. Its sensitiveness to weak signals is, however, reduced. The four element tube combines the desirable characteristics of the two opposing conditions; that is, short spacing may be employed and high voltages applied to the plate circuit with consequent amplification of all signals from the weakest to the strongest. It appears, therefore, that the external element K is the essential element for impressing the received oscillations upon the electron stream, whereas element G permits operation on a favorable point of the characteristic curve.

Any of the well-known circuits for cascade audio or radio frequency amplification, or regenerative amplification, may be employed. An illustrative and simple circuit is shown in figure 2. One terminal of the secondary circuit of the receiving transformer is connected to the external sheath K and the other to the anode or plate P. Figure 3 shows one form of construction for the internal element G.

In the interests of historical accuracy, it may be mentioned that the U. S. Patent specification for this invention was filed April 5th, 1915, and granted January 7th, 1919.

A Four-Valve Cascade Amplifier for Radio Reception

EDITOR'S NOTE—Cascade amplifiers with inductive couplings and resonant circuits between tubes introduce complications which require the attention of an engineer. Because of the simplicity of the four-valve amplifier herewith described, it is especially recommended to the progressive radio experimenter. This is the forerunner of a variety of special circuits and designs that we will present to amateur enthusiasts, from time to time.—Technical Editor.

THE following is a description of a four-valve high-frequency amplifier utilizing one of a series of arrangements described by J. Scott-Taggart in one of his latest articles on valve circuits. It is a complete wireless receiving circuit and possesses the peculiarity and great advantage to amateurs and experimenters of having no inter-valve or step-up transformers. Another advantage is that all the valves, except the first, detect, rectify and amplify incoming oscillations. The first valve is only for amplification purposes. The accompanying diagram, figure 1, shows the complete circuits.

The open or aerial circuit, which has a variable condenser C-1 in series with the aerial, is coupled to the grid oscillatory circuit of the first valve. Another variable condenser C-2 is placed in parallel with the secondary inductance, and although this condenser is for tuning purposes, the inductance should be used as much as possible, and the capacity reserved for fine tuning.

By means of the potentiometer P the grid potential of the first valve is adjusted to a point where best amplification of the oscillations in this circuit is obtained. The separate filament rheostat R-1 also assists in the selection of a suitable adjustment for better amplification.

A small condenser C-3 (about .004 mfd.) placed across the potentiometer allows high-frequency oscillations to pass freely. In the plate circuit is a resistance R-2 of 80,000 ohms. There are similar resistances in the plate circuit of the third and fourth valve.

The high-frequency oscillations which are reproduced in the plate circuit of the first valve are communicated to the grid of the second valve, as the plate circuit resistance R-2 offers too much resistance to the flow of such high-frequency currents. In each grid circuit except the first is a leak R-3 connected between grid and filament. The resistance of the leak is 4 megohms.

As the functions of the third and fourth valves are similar to the second, the filament current should be the same. A rheostat R-4 of 5 ohms, connected as shown, will give a uniform current to these three valves.

The high resistance R-2 can be easily made by scratching grooves, about 1 to 3 inches long, with a sharp instrument on a piece of ebonite and filling them with graphite by simply rubbing a pencil along them. Terminals should be fitted to the ends in such a way as to ensure good contact.

The telephones T, if connected directly in the plate circuit of the last valve, must be of high resistance; but if a step-down telephone transformer is used low resistance telephones will give better results. The latter arrangement is preferable.

The battery which supplies the potential to the plates should be of about 80 to 100 volts, while a 4 volt accumulator is usually best for the filament.

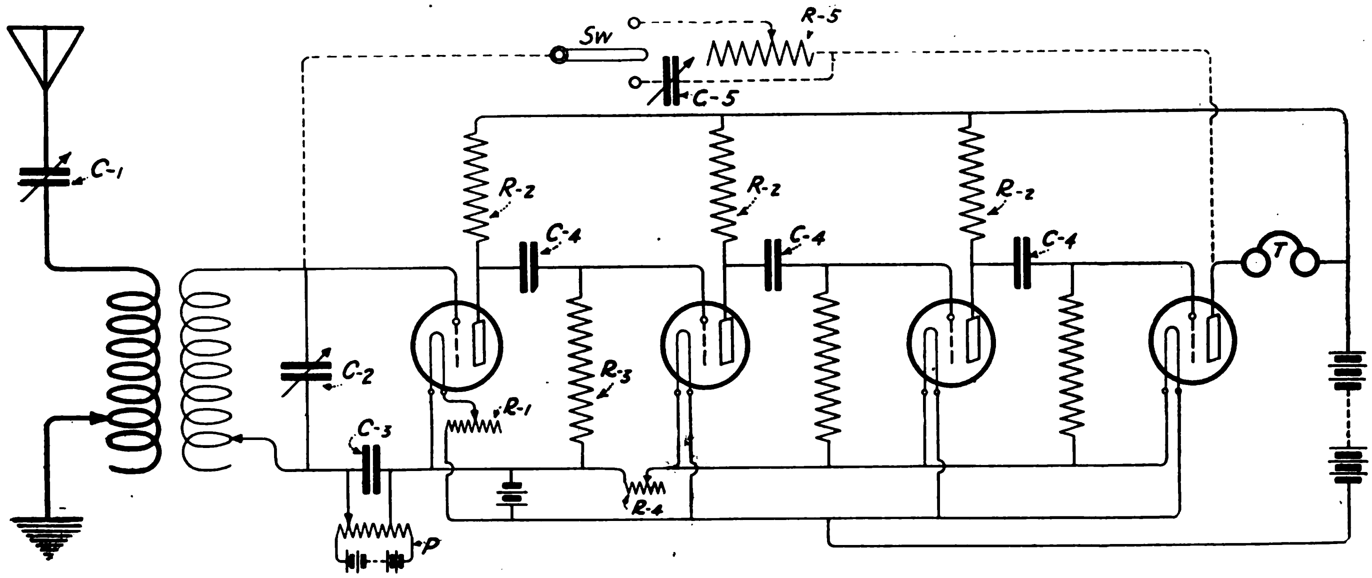


Figure 1—Diagram showing circuits of the four-valve cascade amplifier for radio reception

If the plate of the last valve is connected through a small variable condenser C-5, or a very high resistance R-5, to the grid of the first valve, a further increase in the strength of the signals is noted. By suitably adjusting the resistance or condenser, the circuit can generally be made to oscillate and continuous wave signals may then be received. The resistance and condenser together with a switch S and connections are shown on the diagram by dotted lines.

The results obtained with such an amplifier are very satisfactory. The adjustments are simple, when compared to the circuits employing inter-valve transformers. With transformers the rectification of signals is chiefly left to the first valve which often has to deal with very weak signals and therefore small variations of grid potentials. In this circuit the incoming signals are first amplified.

So simple and economical an amplifier should appeal to amateurs. Its sensitiveness and peculiarity of amplifying weak signals to a far greater extent than strong ones, should be of great assistance to those who wish to receive from stations which hitherto have been unreadable owing to the great distances being spanned or because of using too small an aerial.

A High Frequency Generator for Code Practice

THIS instrument, as constructed by the writer, was made entirely from old apparatus found around the workshop. The generator will furnish enough power to operate from one to six or even more telephones over a line from room to room in the same building. It furnishes an ideal source of high frequency oscillations for fast sending. This is due to the fact that there are no vibrating parts to be stopped and started between each character, as is the case when a buzzer is used. The writer does not claim to be the originator of the principle involved but only of the details of application.

There are three fundamental parts to the generator. "A" is a small Ajax motor which had been rewound with small wire (size about No. 24) to reduce its current consumption. When running it takes from three-quarters to one ampere depending on the speed. "B" is an iron gear two inches in diameter by one-quarter inch thick with twenty-five teeth. The gear used by the writer was taken from an old lathe. It was put on an arbor and turned down to the right thickness and then fastened on the motor shaft by a brass bushing, which was made long enough to allow a set screw to be inserted. "C" is an old pear shaped telephone receiver with the cap and diaphragm removed.

The motor is screwed to one end of base "E" and the telephone receiver is supported by a split block "D." The top of this block is clamped to the lower part by two screws, one in each side of the telephone receiver. A small rheostat may be mounted on the base for regulating the motor speed.

Any type of small motor may be used and a watch case telephone receiver will work as well as the pear shaped one if properly mounted. It is necessary, however, that the line through the center of the telephone receiver be at the same height as the center of the motor shaft. While twenty-five teeth gives the best results with the Ajax motor it is not necessary that the iron gear have exactly this number but it is absolutely essential that it be mounted true on the motor shaft if a clear note is to be obtained.

The diagram figure 1 shows the proper connections. It should be noted that there is no direct electrical connection between the motor and the pear shaped telephone receiver. The power developed by this instrument varies inversely as the distance of the telephone magnets from the iron gear.

E. S. Palmer—*Rhode Island.*

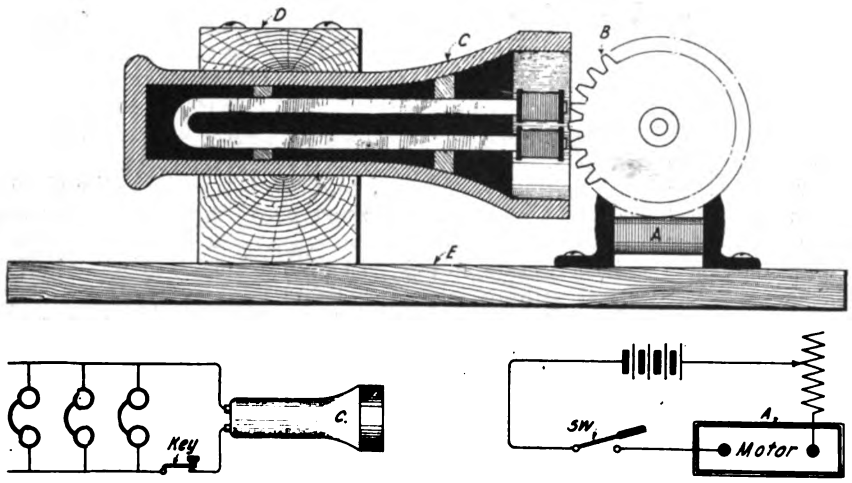


Figure 1—Showing construction and connections of the high frequency generator

Suggestion for Prize Contest, May Issue Wireless Age.

We will pay the usual prizes of $10, $5 and $3, in addition to our regular space rates, to the three contributors who send us the best manuscripts on the following subject:

Which of the two following types of wireless transmitters do you consider to be the most practical for amateur use, namely: the panel type or the isolated instrument type?

Improved Cell Design for High Voltage Battery

ONE of the primary requisites of a modern radio receiving set, is the vacuum valve detector. Of the two sources of direct current necessary to operate this instrument, the high voltage battery gives the most trouble. Flash-light batteries are expensive and short-lived compared to the amount of current used. For those who are content to have test-tubes or other containers arranged in racks, filled with acid, the high voltage storage battery solves the problem, provided they have a convenient source of charging current. From my point of view, I believe that dry cells of a special design, easily constructed by the amateur and small enough to be contained in the receiving cabinet, solve the problem for portable as well as stationary sets.

I think the best shape for the cell, is that of a disc. The best method I have found for making the cells, is to use fibre of cardboard rings to separate the metal electrodes. The outside dimensions are about 1¾ by ⅜ inches. The fibre or cardboard ring has the same outside diameter as the finished cell and the cross section should be about ¼ by ¼ inches square. The rings are soaked in melted rubber compound, such as used to seal storage batteries, and then hung on a rod or nails so they may be removed easily when cold. The negative electrode is a zinc disc the size of the cell and the positive electrode may be copper or other metal depending on the active material in the cell. Carbon cannot be used in this type of cell to advantage.

The method of assembling is to place a zinc disc on one of the rings and then press it down with a hot flatiron until the rubber compound is melted. Then a cold one is put on with pressure until the compound is cold. A tight fitting disc of blotting paper is placed next to the zinc on the inside and the electrolyte, in the form

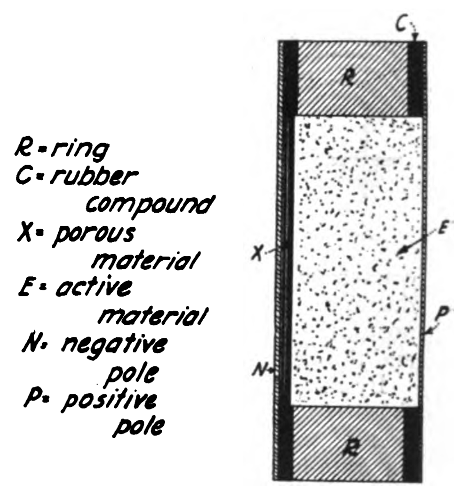


Figure 1—Detailed construction of cell for high voltage battery

of a paste, is next applied. A layer of some depolarizing agent such as black oxide of manganese should complete the filling. Then the other electrode should be sealed in position as the first.

In presenting this suggestion to your readers, I hope some of them will be interested enough to start where I am obliged to leave off, i. e., the finding of the best material for the positive electrode and the electrolyte for the highest efficiency. These cells would have many advantages such as, their cheapness, their small size and ease of construction. Thick metal discs should be placed at each end and a little pressure maintained at their centers by set screws. These act also as binding posts.

LEO. M. LAFAVE—*New York.*

First Aid to the Amateur

BY E. T. JONES

A DETECTOR STAND.

THE detector in figure 1 was constructed mostly of parts of a telegraph sounder and a telegraph key. The support U for the swinging arm A which also carries the contact point originally was the support of a telegraph sounder which held the lever. The crystal holder H is made of a U shaped piece of brass and an 8/32 screw is passed through it at the top to clasp the mineral in its ends. The adjusting knob K is an 8/32 screw with a key knob for its handle. A small piece of tapped hard rubber somewhat similar to the handle of the switch handle on the key gives it a finished appearance.

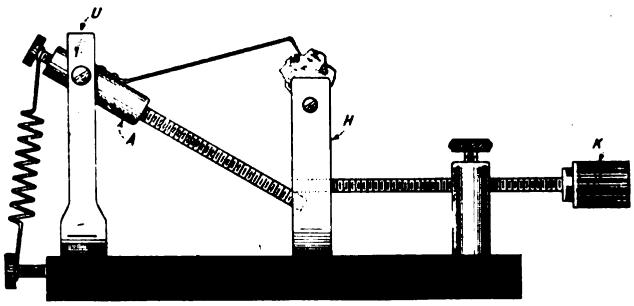
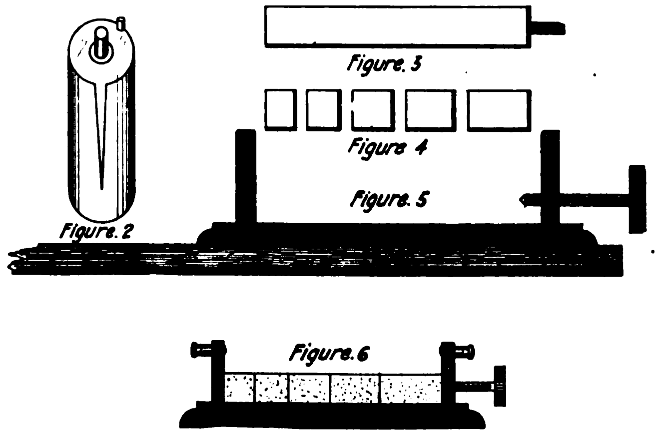


Figure 1—View showing the construction of the detector stand

The main advantages of this detector are that immediately a good adjustment is secured the point can be raised while sending and returned to the exact spot for receiving merely by turning the handle and lowering it to its original position. This is a feature that cannot be obtained from any other form of detector holder. It is optional what kind of mineral is used as the adapter is made to hold any of the well known types. I find this to be one of the best detectors I have had the pleasure to work with owing to the fact that whenever one desires to send he merely has to take the point off the mineral and when finished lower it gradually until the point comes in contact with the exact spot used before.

A COMPRESSED CARBON RHEOSTAT

The variable resistance element of this rheostat is the carbon electrode of an ordinary Columbia No. 6 dry cell. As shown in diagram figure 2, this may be removed by simply splitting the zinc down the edge with the sharp edge of a hatchet. Figure 3 shows the carbon when removed, and figure 4 shows the same carbon with the binding post removed and cut into small blocks of different lengths. Figure 5 shows a suitable stand for the blocks which permits a variable pressure, thereby raising and lowering the resistance at will. Figure 6 shows the completed apparatus.



Figures 2, 3, 4, 5—Detailed construction of the compressed carbon rheostat. Figure 6—The complete device

The blocks can be cut into very thin strips, that is, about ⅜" or ½" thick thereby increasing the resistance. This is a very good instrument for the laboratory and one which is easily constructed and operated.

A CAT WHISKER DETECTOR.

Figure 7 shows the drawings of a novel type of cat whisker detector. The mineral (galena or cerusite) is clamped in the stationary wood support (3) and held by clamp (2). The points as mounted on the copper wire (soldered) which in turn is made fast to the ¼" square brass rod (9). Each point as will be seen from the drawing is made longer than the preceding one, or they can all be the same length but each of different gauge spring wire making each a little more "springy" than the preceding one. The sliding arrangement (8-9 and 10) should be constructed to allow the rod to move to and fro easily on the wood support (6). The detector as a whole is very efficient and a point is readily found

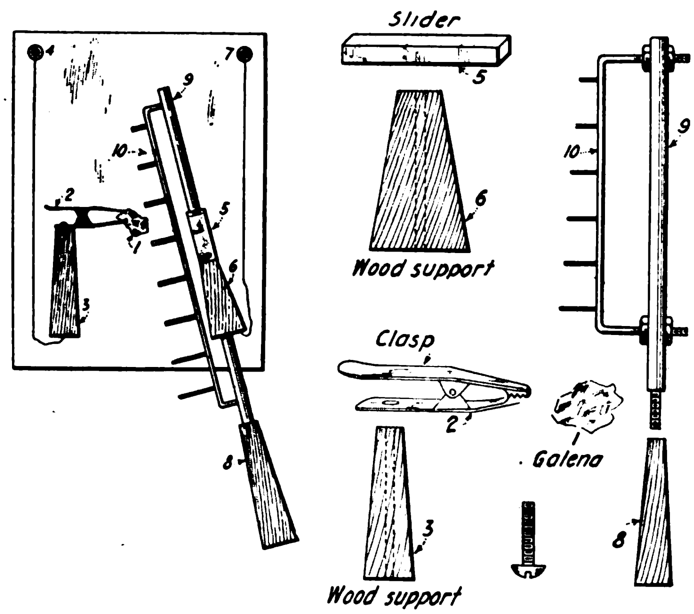


Figure 7—The cat whisker detector illustrated in detail

by sliding the arm (8-9-19) backward and forward—slowly.

A "Quick Throw" Switch.

As shown in figure 8, A and B are knife blade contacts for connection with the switch arm C. H is preferably a hard rubber or hard wood handle. A is supported by an overhanging arm D which is of hard rubber. This ought to make a good antenna change-over switch or a lightning switch. It may be used for many purposes around the amateur station.

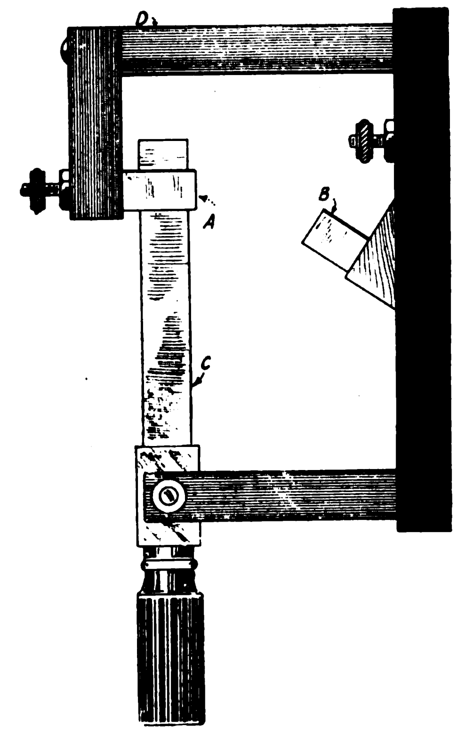


Figure 8—"Quick throw" switch

Donle's Electron Valve for Wireless Reception

COMING on the heels of a multiplicity of patents covering the design and use of vacuum valves for wireless transmission and reception, we have a newcomer for which some startling performances are claimed. Those who have been accustomed to conceive of the electron as moving with great freedom in a vacuum are now called upon to believe that the electron stream actually may pass through glass under certain conditions of temperature. H. P. Donle of Connecticut, is credited with the discovery.

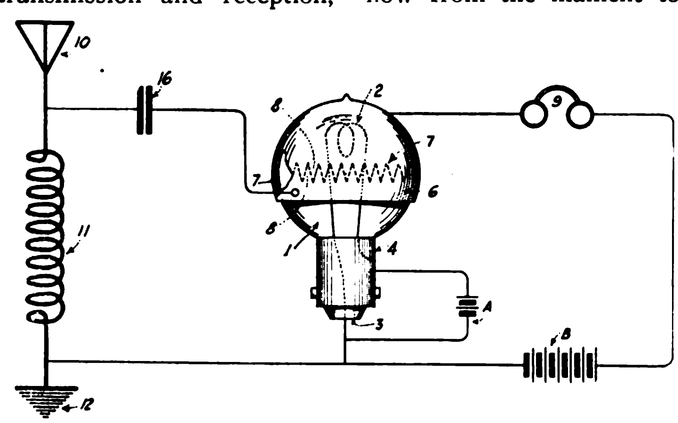


Figure 1—Donle's vacuum tube connected for radio reception

In one type of his valve shown in figure 1 the elements corresponding to the grid and plate of the usual tube are placed on the outside of the glass container. The external metallic covering 6 called the "deflector" is insulated from another metallic covering 5 called the "target." These elements are in jagged conformation which the inventor remarks to be essential to successful operation. The target and the deflector may be of silver or copper.

In his own language: "The two external conducting elements are shown as having their adjoining edges relatively closely approached but as having a clear insulating space 7 therebetween. The adjoining edges of the two elements furthermore, are indicated at 8 as of serrated or jagged outline, thus providing a zigzag intervening space between the two members. This in effect increases the areas of the two elements which are opposed to each other.

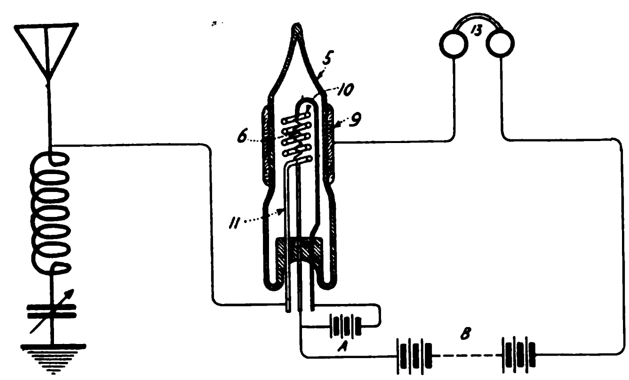


Figure 2—Modified form of tube in a modified circuit

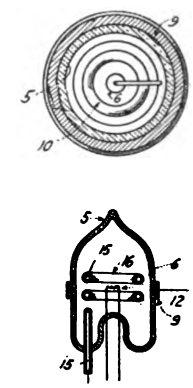


Fig. 3 (top)—Cross section
Fig. 4 (bottom)—Vertical section

"It is desirable that as many as possible of the electrons which control flow from the filament to the target shall be influenced by the deflector. In order that the deflector influence these electrons, its electrical field should be as close as possible to the target. The portion of the target not affected by the electrical field from the deflector will receive an uninterrupted flow of the electrons from the filament. As an amplifier, the action depends upon the volume of electron control. The deflector should therefore control as great a percentage of the electron flow as possible. This in effect is what is accomplished by the intermeshing or 'overshadowing' of the target by the deflector."

According to the inventor, when the temperature of the glass is raised to 100° C. or more, it becomes conductive to the electron stream and some current flows from the battery B through the glass and across the intervening space between the plate and filament. The circuit may be traced from one terminal of the B battery through the telephone 9 to the target 5. The other terminal of the B battery is connected to one side of the filament. The deflector 6 is connected to a terminal of the secondary circuit through the condenser 16. Direct coupling is shown at 11.

The inventor declares that the electrons flow through the warm glass or other normally non-conducting wall of the globe and not simply through the evacuated space as in tubes heretofore. He states that the efficiency of the tube is not dependent solely upon the maintenance of the vacuum. Furthermore, he believes that the electron discharge at the inside of the bulb may be considered, because of its unilateral conductivity, a polarizing conductor or polarizing medium. The electrode on the outside of the bulb is of a material that does not polarize in contact with the glass and he therefore terms it a nonpolarizing layer or conductor. He believes that the deflector, connected to a source of radio frequency oscillations, varies the electron current in the tube much in the same way as in the ordinary three element tube with all electrodes inside the bulb.

A tube of modified construction and a modified circuit are shown in figures 2, 3 and 4. Figure 2 shows the tube with the filament 6 inside the grid element 10, the container being surrounded by the metallic conductor 9 which forms the anode for the tele-

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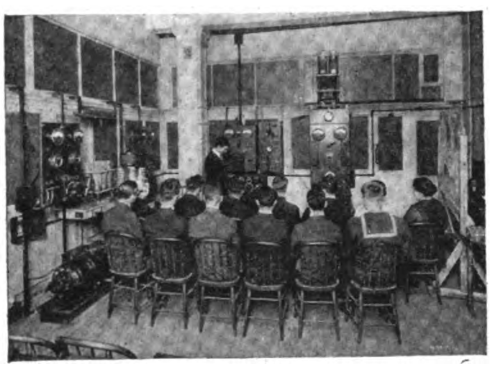

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phone circuit. The grid element 10 is connected to one terminal of the antenna circuit through the wire 14. This constitutes an open oscillation circuit which has been covered by patent specifications of another inventor. Figure 3 is a cross sectional view of the tube on the plane 2-2 in figure 2. Figure 4 is a vertical sectional view of a modified form of construction.

It is to be noted in circuit of figure 2 that the plate current furnished by the B battery is assumed to flow from the external element 9 through the glass container to the filament 6.

The operation of the tubes and the circuits in figures 2, 3 and 4 is described by the inventor as follows: "The filament when energized by the battery A heats up the globe which, as before stated, is usually made of glass or other material normally non-conductive at room temperature but which when heated to a higher temperature of say, 100° C. or over, becomes conductive to a certain degree, whereupon current from battery B passes from the anode through the heated glass to the layer of electrons on the inner wall of the globe, said current being conducted between this wall and the filament by the electron stream. If a charge is now placed upon the controlling member, as by means of radio oscillations, for instance, the flow of current through the glass is decreased by the decreasing in area of the electrons laying upon the inner wall of the globe, the controlling member apparently acting in this case to absorb unto itself a certain number of these electrons."

The operation of the tube in figure 2 is in general similar to that first described, the controlling member being connected to one terminal of the oscillation circuit. Quoting the inventor:

"The polarizing layer of electrons or ions in contact with the inner wall of the globe, it will be seen forms in effect a polarizing conductor which in combination with the non-polarizing conductor in contact with the outer wall of the globe makes of the device a rectifier which may be used as such. The device may also be used as an amplifier in which event the connections will be such that the area of the polarizing conductor will be varied according to the energy to be amplified."

Regarding the special construction in figure 3, the inventor states: "The construction illustrated in figure 3 differs from the first form described, particularly in that both the anode and the controlling member are separated from the filament or electron source by a wall of glass. In this case the anode is located on the outside of the globe 5, as in the first instance but the controlling member is in the form of a metallic coating 15 of silver, or the like, lining the inner wall of a sealed glass tube 16 located within the globe and surrounding the filament."

The Effect of a Shunt Condenser in Tuning the Primary Circuit of a Receiving Set

By Ralph R. Batcher

EDITOR'S NOTE.—A condenser shunted across the primary of a receiving tuner does not always give the desired results. Just what may be expected in practical operation, the author explains by a simple mathematical analysis. Careful study of this article may help the experimenter to understand some of the apparent "freaks" met with in "parallel tuning."—Technical Editor.

THE effect upon the wave length of the antenna circuit when a condenser is placed in series with the localized inductance, is well known. This method is often used to cut down the wave length of the circuit. However, the practice of placing the condenser in parallel with this inductance, does not always lead to the results that were expected.

The circuit shown in figure 1 typifies the shunt connection. If we allow the letter R to stand for the ratio between the wave length resulting from particular adjustments of L_1 and C with respect to fundamental wave lengths of the antenna, i.e.,

(1) $R = \lambda_1 \div \lambda_0$, it will be shown in the latter paragraph of this article that the following relation is obtained:

(2)
$$\frac{C}{C_0} = \frac{R^2 L_0}{L_1} + \frac{R^2}{1 - R^2}$$

It would be advantageous to solve the above equation for R but the solution of a fourth degree equation is in this case more complicated than in the above form. It is also impossible to plot the above equation as it stands owing to the fact that it contains five variables. However, L_0 and C_0 are constants for any one station so that absolute values can be ascribed to them and an illustrative solution worked out by curves.

Suppose that $L_0 = 50{,}000$ c.m. and $C_0 = .00025$ mf. (which are the approximate values of an antenna 60 feet high and 60 feet long). The equation now contains but three variables and can be more readily plotted. Curves showing the value of R with C ranging in value from 0 to .005 mf. for several values of L_1 are plotted in figure 2.

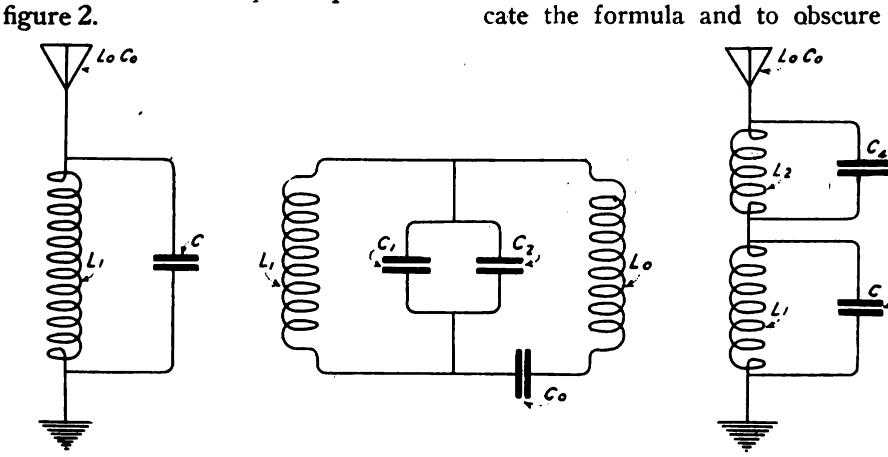


Figure 1 Figure 3 Figure 4

Symbolic diagrams of "parallel tuning"

It will be seen that this circuit can be used for lowering the wave length as well as raising it. This principle has been used for many years by certain commercial companies to lower the wave length of an antenna to a value below the natural wave length, but amateur operators have rarely made use of it knowingly.

Similar curves may readily be drawn for any antenna if its inductance and capacity are known. In this article the effective values of the inductance and capacity only are used. There has been no attempt to consider the distributed nature of L_0 and C_0, as its introduction would tend to complicate the formula and to obscure the results that were to be disclosed in this article. Other formulæ* have been recently published that can be applied to the distributed values of L_0 and C_0 to obtain their effective values. These latter values should be used in formula 2.

In plotting these curves it will be

* See Bureau of Standards Bulletin No. 74, pages 71-86.

found that the computations are simpler if values are assumed for R and for L_0 and the corresponding value of C obtained by substituting these values in the formula.

It will be seen by analyzing the sample curves that there are certain wave lengths, around the fundamental wave length of the antenna that cannot be received with this circuit, except with very small values of L_1 and C.

The derivation of the formula is as follows:

The equivalent circuit corresponding to figure 1 is shown in figure 3.

$$\text{Let } \lambda_0 = 59.6\sqrt{L_0C_0}$$
$$\text{and } \lambda_1 = 59.6\sqrt{L_1C_1} \qquad [2]$$

An emf. of frequency n will effectively "split up" the condenser C into two capacities C_1 and C_2 so that both cir-

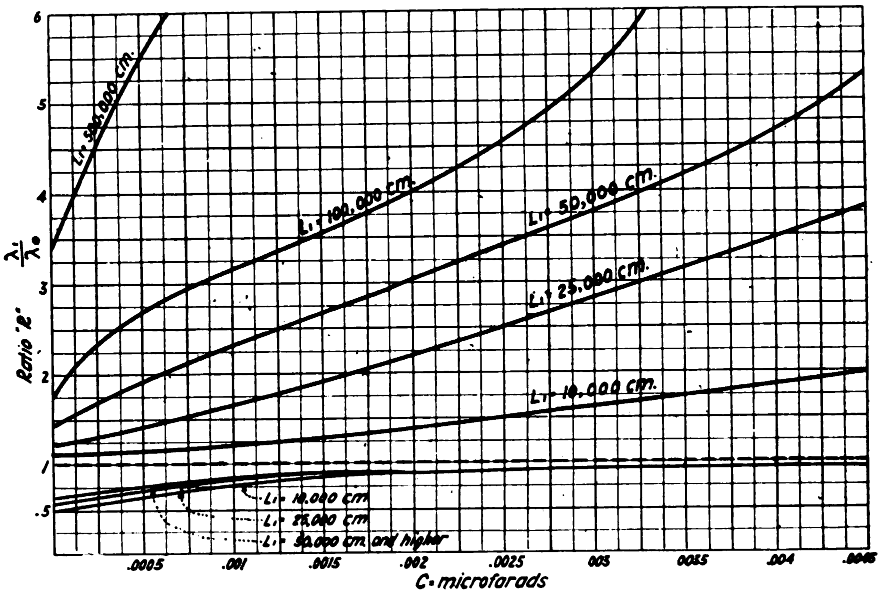


Figure 2—Graphic curves showing ratio values in shunt condenser connection

In other words the circuit L_1C acts as a high impedance for these wave lengths. It will also be noticed that there are certain combinations of L_1 and C, that make the circuit responsive to slight changes of capacity, and that at other places a large variation of the condenser C is needed to produce a given change of wave length. Doubtless every amateur has noticed this condition in practice but was unable to account for it. The circuit will always respond to two wave lengths, one above the other below the fundamental wave length of the antenna.

Applying this method to a transmitting circuit to enable the operator to use a rather large antenna for 200 meter waves, it will be seen that some sort of a filter circuit must be added in series with antenna, to shut out the unwanted frequency. This additional circuit added to the antenna circuit would probably decrease the efficiency of the apparatus, but it remains to be tried out in practice to determine whether it is better than a plain series condenser to accomplish the same result. Figure 4 shows the apparatus needed to cut the natural wave length down in this manner. L_2 and C_4 must be of such a value that they correspond to the undesired wave length produced by the condenser C.

cuits L_1C_1 and $L_0C_0C_2$ will if possible be in resonance with the frequency n. Then

$$L_1C_1 = \frac{L_0C_0C_2}{C_0 + C_2} \qquad [3]$$

squaring eq [2]

$$\lambda^2_1 = \frac{L_0C_0C_2(K)}{C_0 + C_2} \qquad [4]$$

$$\text{and } \lambda^2_0 = L_0C_0(K)$$

solving [4] for $C_2 \div C_0$

$$\frac{C_2}{C_0} = \frac{\lambda^2_1}{\lambda^2_0 - \lambda^2_1}, \qquad [5]$$

from eq. [2] and [3]

$$\frac{C_1}{C_0} = \frac{\lambda^2_1 \times L_0}{\lambda^2_0 \times L_1}, \qquad [6]$$

adding [5] and [6]

$$\text{Let } C = C_2 + C_1, \text{ then}$$

$$\frac{C}{C_0} = \frac{\lambda^2_1 L_0}{\lambda^2_0 L_1} + \frac{\lambda^2_1}{\lambda^2_0 - \lambda^2_1},$$

substituting $\lambda_1 = R\lambda_0$,

$$\frac{C}{C_0} = \frac{R^2L_0}{L_1} + \frac{R^2}{1 - R^2}$$

This last formula is the one given at the first of the article.

Contest Winners for the April Issue

In response to the call in the February issue for manuscripts concerning the ideal amateur set, prizes have been awarded to the writers of the following articles. The subject upon which the contest was based was: What, in your opinion, is the most efficient receiving set for amateur wave lengths, and what should be the dimensions of the antenna and the tuning coils for best results?

First Prize—A Short-Wave Regenerative Receiver

THE receiving tuner herein described is designed for use on an average amateur aerial having a natural wave length of about 175 meters. An inverted L type aerial, 80 feet long and 60 feet high, answers these requirements, although the length and height may be varied to fit the location. A natural period greater than 175 meters is not recommended if the station is to operate on 200 meters, as an aerial of such dimensions will not permit sufficient inductance in the primary of the receiving tuner, nor in the secondary of the transmitting oscillation transformer, for efficient transformation.

In choosing a type of receiver for amateur purposes, and for construction by amateurs, three fundamental points should be considered: 1st, efficiency; 2nd, simplicity of construction; and, 3rd, ease of operation. That these points have been carefully kept in mind in the tuner described, the following will bear out.

With respect to efficiency, it should be noted that this type of circuit has been adopted by the Navy Department, the U. S. Signal Corps, and by many foreign governments. The size of wire for the coils herein specified will give maximum conductance, which IS IMPORTANT, contrary to the popular belief that, because the vacuum tube is a potentially-operated device, its efficiency is not lowered by using fine wire. The absence of variometers eliminates another source of energy loss, and the tuning of the secondary by a condenser instead of taps, makes a further improvement.

The simplicity of construction will be apparent after noting the details given. There is an efficient circuit employing variometers, but the construction of a variometer is much more difficult than the simple coils required in this tuner.

This receiver consists of three coils, a primary, a secondary, and a tickler coil. The primary and secondary are each shunted by a variable condenser of 0.0005 mfd. capacity, and a variable condenser of 0.001 mfd. capacity is shunted across the high potential battery.

The primary coil is a tube three inches in diameter, wound for a distance of one inch with 30 turns of No. 22 D.S.C. magnet wire, and tapped to two 5-point switches for single turn variation. This coil has a total inductance of 0.1 millihenries, and if used on the aerial described above, with the shunt condenser, will respond to wave lengths ranging from 200 to 600 meters.

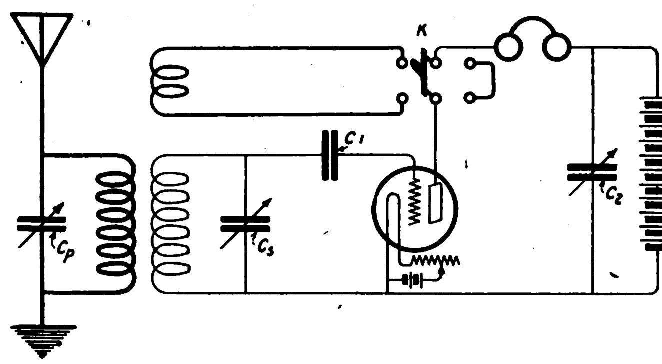


Figure 1—First prize article

The secondary coil is a tube 2½ inches in diameter, wound with 50 turns of No. 24 D.S.C. magnet wire. No taps are taken from the secondary, the variation of wave length being obtained by the variable condenser. The secondary has an inductance of 0.14 millihenries, and will respond to the same range of wave lengths as the primary. A maximum separation of 6 inches between the primary and secondary coils should be provided, but the constructional details can be varied as individual requirements may dictate.

The tickler coil is wound on a wooden ring, the center of which is turned out large enough to permit sliding the ring over the secondary. A groove is cut out on the edge of this ring, the inside diameter of which is 3 inches, the width ⅜ inch. In this groove are wound 12 turns of No. 18 annunciator wire, in 3 layers of 4 turns each. A D.P.D.T. switch is provided

for throwing the tickler coil out of circuit when a plain valve connection is desired, and the coil is so designed that its insertion will not detune the secondary circuit.

When operating this receiver, the desired signal is tuned in with the switch K to the right. When this is accomplished, the tickler coil is thrown into the circuit and moved over the secondary until regeneration occurs. Condenser C2 is then adjusted, and the coupling gradually loosened, so that freedom from interference will be obtained. It is possible to receive strong signals with a very loose coupling, as the amplification obtained (3 to 6 times) will compensate for the loss of energy resulting therefrom.

By the use of suitable loading coils in the primary and secondary circuits, this tuner will respond to waves as long as 2,000 meters, but it is advisable to remove these coils completely from the circuits when short waves are being received.

In conclusion, I would say, the construction of this tuner will prove a revelation to many amateurs who have been content with the simple vacuum tube connections heretofore employed, and will certainly repay anyone for the time and materials expended.

Arno A. Kluge—*California.*

Second Prize—A Receiving Set for Amateur Wave Lengths

THE amateur is, of course, primarily concerned with the reception of signals from amateur transmitting sets which usually operate at the wave length of 200 meters. To do this most efficiently he ought to design a set especially for short waves. Such a set was constructed by the writer in the Physics Department of the State College for Teachers at Albany, N. Y. and exceptional results were obtained with it. Amateur stations in Ohio, New Jersey and even Nebraska were heard far above readable loudness. The wiring diagram appears in figure 1.

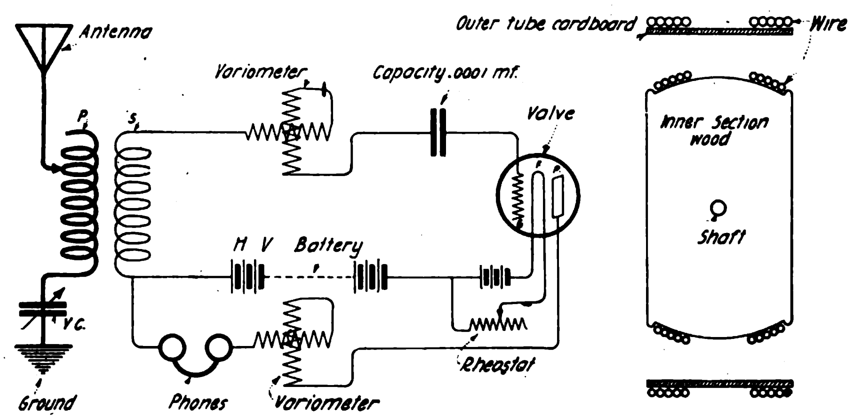


Figure 1—Second prize article

A regenerative vacuum tube receiver is used. With such a set it is advisable to use small capacities and provide a means for carefully regulating the inductance continuously from a minimum to a maximum. Such variation may be effected by placing two coils, having equivalent values of inductance, concentrically with provision for rotating the inner one to vary their self-inductance.

The mutual induction between two wires varies inversely as the distance between them. It is, therefore, well to construct the inner coil of the variometer so that its winding will be as close as possible to that of the outer coil. In order to do this the inner coil is wound on part of a spherical surface, that is, a section of a ball, made of wood. This section is 3 inches in diameter and 1½ inches wide. It is made to rotate by means of a brass shaft, within a carboard tube 1½ inches wide of the correct diameter to allow clearance. The tube and the inner core are both wound nearly full with equal quantities of No. 28 copper wire in one layer. The coils are then arranged in boxes and provided with a handle carrying a pointer which travels over a scale of 180 degrees.

Two of these variometers are connected in the circuit of a specially constructed coupler. The primary of the coupler contains some 20 turns of No. 28 wire on a cardboard tube about 6 inches in diameter. The secondary coil has 15 turns of wire on a tube 5½ inches in diameter. Provision is made to allow very loose coupling between the primary and secondary. A complete circuit diagram is shown in figure 1.

It would be of further advantage to wind the outer coil on a curved surface to bring the two windings in close proximity. This, however, is difficult without proper tools. The side drawing of figure 1 gives the constructional details of the variometer.

The antenna should be as high as possible. A two wire aerial 150 to 200 feet in length with the wires spaced 4 to 6 feet will do. The variable condenser in series with the primary circuit gives very close tuning and is essential for very short waves. An additional variometer might be connected in the antenna circuit.

Although amplifiers are in use at the college laboratory, the records mentioned above were made without an amplifying device of any sort.

E. L. LONG—*New York.*

Third Prize—Amateur Radio Receiving Station

THE set I am about to describe is very efficient for wave lengths between 200 and 3,000 meters. It is easily constructed, low in cost and employs but one vacuum tube. I use two couplers and two aerials. One aerial and tuner are built specifically for 200 meters, and the second combination for wave lengths up to 3,000 meters.

The large coupler may be any good make of transformer the operator has on hand, but I recommend that the 200 meter be specially constructed. By coupled in figures 1 and 2 should be 3 inches long, 3 inches in diameter, wound with No. 24 S.S.C. wire tapped so as to allow a variation of one turn at a time. The secondary should be 2½ inches long and 2½ inches in diameter wound for 1¾ inches with No. 28 S.S.C. wire. It is not necessary to take any taps off of the secondary. A small variometer is used in the secondary circuit to allow very fine tuning.

A full description of a variometer which is very efficient for this purpose may be found in the book "How to Conduct a Radio Club."

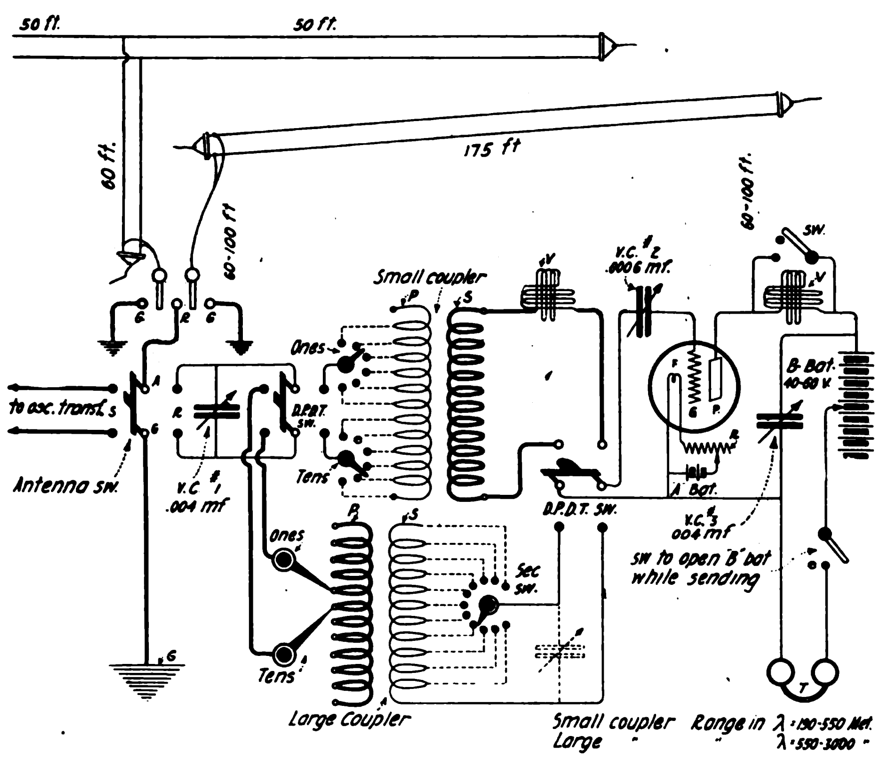


Figure 1—Third prize article

means of a change-over switch either coupler and aerial may be employed as desired. I consider the "T" type antenna to be the most efficient for short wave work, but for longer wave lengths I would advise a separate antenna of the "L" type about 175 feet long and as high as possible above the earth. The higher it can be elevated the longer the range. The "T" type should be 100 feet long and 60 feet high of 2 wires of stranded phosphor bronze spaced about 8 feet apart, the vertical section being separated about 15 feet above the earth by an 8 foot spreader. For the "L" type only one wire is necessary, 175 feet long and 60 to 100 feet high.

The primary coil for the short wave

A small variometer of a simple design may be constructed that will answer this purpose very well. The outer coil should be 3½ inches in diameter, 1½ inches wide, wound with 25 turns of No. 28 S.S.C. wire. The inner coil should be 3 inches in diameter wound with No. 28 S.S.C. wire. Care should be taken that the inner coil has the same amount of wire as the outer coil. Cardboard tubes may be used and the wire should be well shellaced. It may be mounted on a base and placed on the operating table, or if so desired it can be mounted on the back of the panel board, with the rod that is used for rotating the inner coil extending

through the panel. With the pointer and scale on the front of the panel, it presents a very neat appearance.

The large coupler has a primary 5 inches in diameter and 6 inches long wound with No. 24 S.S.C. wire tapped so as to allow a variation by one turn at a time. The secondary should be 4 inches in diameter, 5 inches long wound with No. 28 S.S.C. wire, tapped every ⅜ of an inch.

Variable condenser No. 1 should have a capacity of about .004 mfd. Variable condenser No. 2 has about .0006 mfd. capacity. The variable condenser shunted across the telephones has a capacity of .004 mfd. It can be replaced by a fixed condenser of similar capacity but it reduces the efficiency especially in the short wave set. Variable condenser No. 3 can also be replaced by a small fixed condenser made of a piece of mica 2 x 4 inches covered on each side with tin foil; but for the best results I believe a small variable should be used.

The variometer in the plate circuit should be the same in design and size as the one described above, and if properly constructed will give considerable increase in signals on the low waves. It should be shunted by a small switch so that it may be cut out when using the larger transformer.

By means of the two double pole double throw switches shown in the diagram, either of the couplers may be connected to the valve detector. This does away with the dead end effects that are particularly noticeable on the two hundred meter wave lengths. This set may not look so well as the cabinet type of short wave regenerative receivers on the market for amateur use, but if properly constructed it will give equal results. The appearance of this set can be increased considerably by mounting it on a panel except the tuning couplers which should be mounted on the operating table. The telephones can be any standard make such as the Brandes or Murdock 2,000 ohm type which I find to give equal if not better results than the telephones ordinarily employed. A fundamental wiring diagram appears in figure 1 and the assembled apparatus with all connections in figure 2.

W. S. Taylor—*New York.*

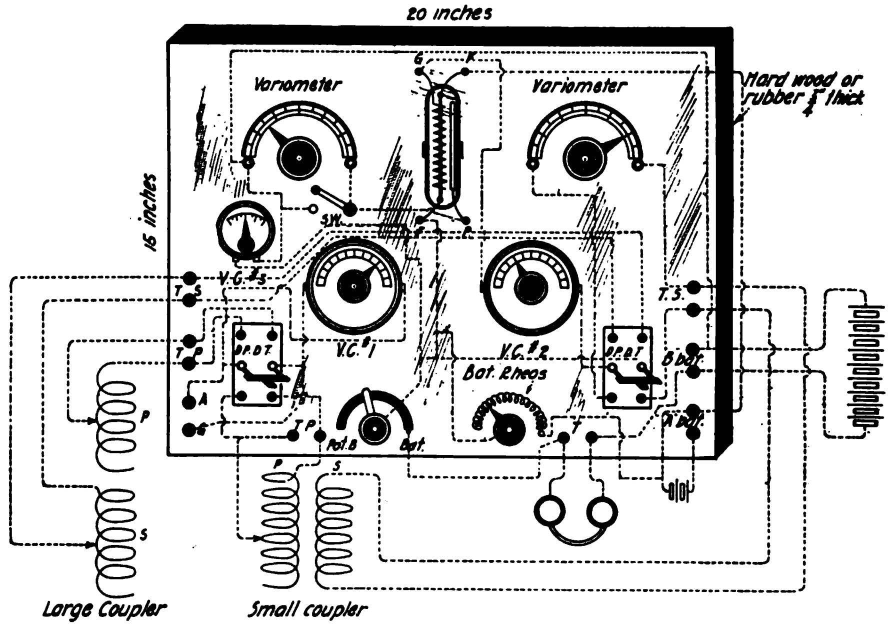


Figure 2—Third prize article

A Method for Reviving an Audion "B" Battery

I THOUGHT perhaps it might be of interest to amateurs to know how to revive their old "B" batteries used with three element vacuum tubes and save money. I carefully stripped the old cells of their zincs, leaving the wax on top of each carbon and scraped the decomposed zinc from the bag around the carbon. I made new zinc cups, lined them with paper and soaked them in a solution of zinc chloride and saturated ammonium chloride. I also soaked the carbon sacks in the same solution. The proportion of the two chemicals is not very important, one part ZN CL to two or three NH_4CL being used. The cells worked over in that way gave 1.4 volts. The zincs were formed around a cylinder of the right diameter and soldered. It is a rather big job, but if ten-cent flashlight batteries are not to be had it saves money.

Jacob Jordan—*Indiana.*

The Monthly Service Bulletin of the

National Wireless Association

Founded to promote the best interests of radio communication among wireless amateurs in America

Guglielmo Marconi, *President* — J. Andrew White, *Acting President* — Alonzo Fogal, Jr., *Secretary*

Pre-War Amateur Radio Work

MANY of the radio amateurs throughout the United States will be interested in the pre-war distance records made by Station 6EA, at Los Angeles, California, some of which have never been published.

Radio amateurs on the Pacific Coast have done some very excellent long distance work both in regard to transmission and reception. Our amateur radio station, for one, obtained good results, especially between the hours of ten-thirty at night, and two and after, in the morning. Using a homemade regenerative receiver, the writer picked up 9ZN of Chicago, (1730 miles) on a wave of 425 meters, calling 9ZF of Denver. This occurred during March, 1917, on a clear evening after midnight. In February, 1917, we heard 7ZC of Lewiston, Montana, (1,005 miles), also on a 425 meter wave. He was working with 7ZN at Vancouver, Washington. Another night in February we picked up two stations on 425 meters. One was 9XN at Grand Forks, North Dakota, who was calling 9XV, 5BV and 8YI, between the hours of ten and midnight. The other one was 5ZC at Dallas, Texas, who was heard working with 5ED after midnight. These distances are, respectively, 1,445 and 1,240 miles. The above mentioned distances are the maximum we have been able to cover.

We have had excellent results in transmitting over long distances. Our transmitter is entirely homemade and of half-kilowatt capacity. The aerial is of the inverted "L" type, fifty feet high and forty-five feet long, giving a wave length of about 195 meters.

We received a letter from the operator at the Marconi station KDU, at Juneau, Alaska, stating he had heard our signals quite distinctly while we were working with 7ZN, on March 1, 1917, at eleven-fifty p. m., Sitka time (12.50 A. M. Pacific Coast time). The distance to Juneau, Alaska, from Los Angeles as computed by spherical trigonometry, is 1,840 miles, which is our record transmission. The operator at KDU was using the Marconi type 101 tuner, crystal detector, and Baldwin Mica diaphragm receivers.

The steamer D. G. Scofield (WRD) heard our station 1,289 miles west of San Francisco, which is approximately 1,500 miles from Los Angeles. This same ship picked up our station when 20 miles north of Seattle. Station 9ADL of Milwaukee, Wisconsin, heard our signals, the distance being 1,730 miles.

The above is a fair illustration of the possibilities in amateur long distance communication previous to the war. By utilizing some of the discoveries made during the war, these records will undoubtedly be excelled.

Howard C. Seefred—*California.*

Undamped Stuff

I tired of interference, so I though it would be fine
To buy a tube and build myself a feed-back heterodyne,
To hear the latest line of dope, swift-wing'd by night and day,
From Eiffel Tower or Babylon, Iceland and far Cathay.

(*That was the prolog*)

I scraped up microfarads, enough to choke a horse;
A flock of milihenries too, to balance up, of course;
Then I beat 'em all together till the racket made me deaf,
And multiplied each screw and bolt by L C 2 Pi F,
I made a characteristic curve, I liked the way it bent,
I smeared the proper volts and juice upon the filament,
And hooked up just enough dry cells for pressure on the plate.
Nothing went amiss, I thought—but it wouldn't oscillate!
I tied a new condenser with a leak up to the grid;
Then I jerked it out again; but no matter what I did,
My efforts were in vain; I tried most everything
But no canary bird inside woke up to start to sing.

Avaunt, O, feed-back heterodyne! and straightway let's prepare
Another way to hear the lay of sigs in ether'd air.
From dark to dawn, to list, adorn'd, in chaste and simple nighties,
While the stuff comes in on bent hairpin and good ol' iron-pyrites.

The Vacuum Tube Transmitter for the Amateur

AMONG the manuscripts published in the January issue of THE WIRELESS AGE on interference, the one by A. J. Holborn is of real value. The vacuum tube transmitting set is practical. It is easy to operate when the proper tubes can be had. Of course, any undamped wave sender is more efficient than spark sets.

Any oscillating audion set such as used for receiving from arc senders may be used for transmitting. I wonder how many amateurs ever stopped to think that their heterodyne receiving sets are sending out feeble undamped waves.

I have repeatedly used an ordinary receiving set of the above type to transmit over a distance of almost one-half mile. The source of energy was the small B battery in the plate circuit. With a standard set using 50 watts I have carried on excellent communication over a distance of 18 miles. I give these examples to show that my "dope" is not theoretical but is based upon actual experiments.

Among other tests, three sets of equal power were operated at equal distance from a receiving station at only 10 meters difference in wave length. The receiving operator was able to read any of the three at will without undue interference from the others.

By using the hook-up formerly employed in the receiving set and substituting a larger tube and a higher plate voltage, considerable power may be radiated. In case one tube is not sufficient, they may be operated in parallel.

Two pieces of apparatus called for which may be difficult to obtain are a proper tube and a source of high voltage for the plate circuit. It is customary to use a motor generator set to change any convenient source of current such as 110 volts AC into about 300 to 500 volts DC. A high voltage battery of reasonable cost may be on the market at a later date.

GEO. E. BAKER—*Texas.*

Queries Answered

Answers will be given in this department to questions of subscribers, covering the full range of wireless subjects, but only those which relate to the technical phases of the art and which are of general interest to readers will be published here. The subscriber's name and address must be given in all letters and only one side of the paper written on; where diagrams are necessary they must be on a separate sheet and drawn with India ink. Not more than five questions of one reader can be answered in the same issue. To receive attention these rules must be rigidly observed.

Positively no Questions Answered by Mail.

H. P. M., Royse City, Texas:

The crystaloi detector will not respond to undamped oscillations, therefore your first query does not require further comment.

In reply to query No. 2, the dimensions of an aerial for receiving foreign stations abroad are immaterial, provided you possess sensitive receiving apparatus. A cascade radio frequency amplifier will permit reception of signals over enormous distances with small antennae.

* * *

A. N. W., Bolivar, N. Y.:

Ques. (1)—I have a telephone generator giving about 115 volts and 2 to 3 amperes. When run at 2,000 R.P.M., it should give over 300 watts, 60 cycle A. C. Barring difficulties, such as heating, could this generator be used to excite a ¼ kw. closed core transformer for wireless transmission or experiment?

Ans. (1)—If the output of this generator is as you state, and it does not overheat on full load, we see no reason why it could not be employed in the manner you state.

Ques. (2)—I have an 8 volt, 10 ampere dynamo which I desire to employ to charge a storage battery to be placed 800 or 900 feet from the source. What size wire would you suggest as being desirable to carry the necessary charging current with a minimum of line loss?

Ans. (2)—A No. 6 or No. 8 wire would have sufficient current carrying capacity to meet this requirement.

* * *

W. P. B., Freedom Station, Ohio:

In reply to your first query, we are unable to give you data regarding an earth transmitting system, because you have not stated the type of apparatus you wish to use. If you will go to a local Public Library and obtain a copy of Fahie's "History of Telegraphy," you will find complete descriptions of various types of induction telegraph systems.

In regard to the matter of receiving aerials: the dimensions make little difference if you use a vacuum tube amplifier as a detector. For the reception of amateur wave lengths, the antenna should not be more than 120 feet in length. Two wires will do as well as four wires.

We have no data on the Arlington and Key West press schedules, but we presume that the old schedule will be adhered to in the future.

Replying to your fourth query: The radio stations of the United States employ both damped and undamped wave transmitters. Ships generally use spark transmitters although the larger battleships have installed high power arc transmitters for long distance communication.

The book "How to Conduct a Radio Club," will give you complete dimensions of a receiving tuner suitable for reception of the time signals. The text-book "Practical Wireless Telegraphy" contains a description, with dimensions, of a receiving tuner for wave lengths up to 12,000 meters.

* * *

M. L., Champaign, Ill.:

Your questions regarding a specific type of vacuum tube are too general. In fact the data you have supplied is insufficient to give you definite information regarding the circuit for this particular tube. Various connections are used in vacuum tube transmitters and some of them cannot be published until the signing of the armistice. The text-book "Vacuum Tubes in Wireless Communication" gives numerous diagrams covering the vacuum tube situation in general.

Regarding the 500 watt generator for the vacuum tube: It is suggested that you communicate with the Crocker-Wheeler Co. of New York, for further details.

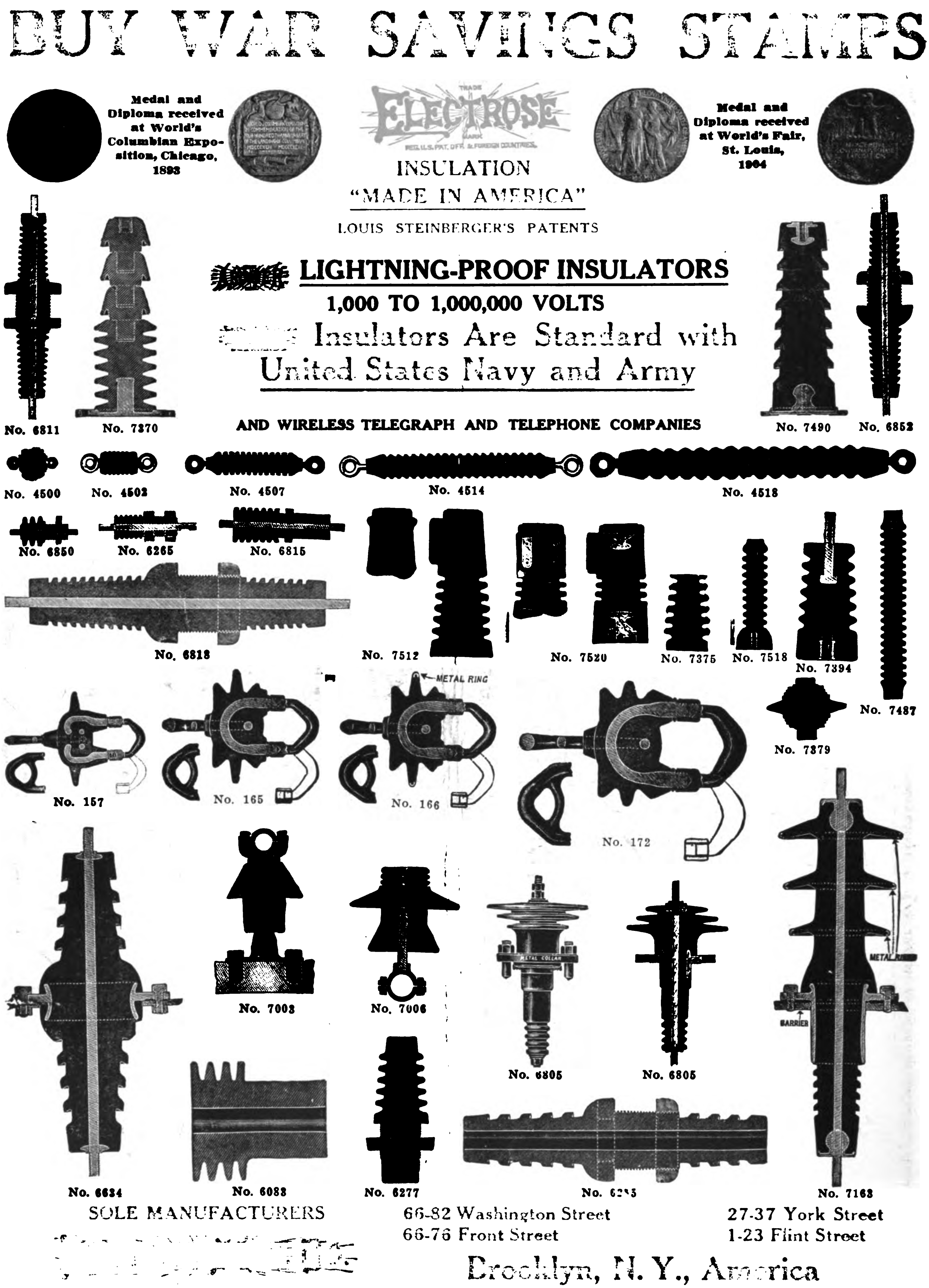
May, 1919 20 Cents

The WIRELESS AGE

Volume 6 Number 8

Radio Instruction Which Prepares the Men Who Go Down to the Sea in Ships

Notable Articles On Receiving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The Wireless Age

Edited by J. ANDREW WHITE — E. E. BUCHER, Technical Editor

Vol. 6 — No. 8

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Index of Equipment

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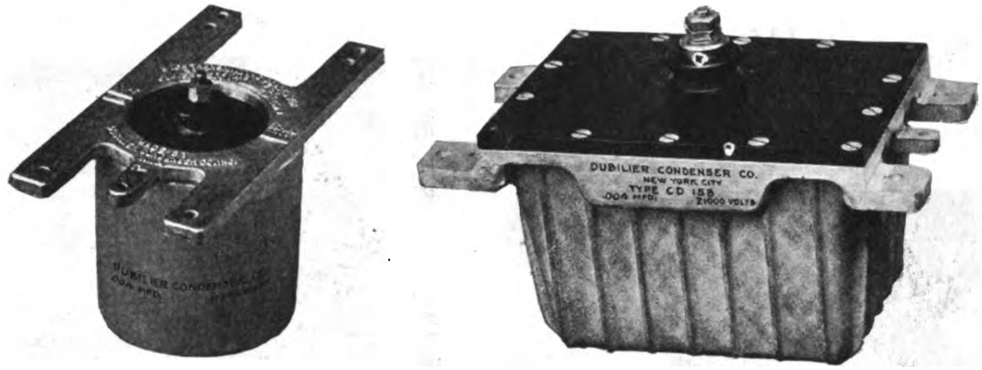

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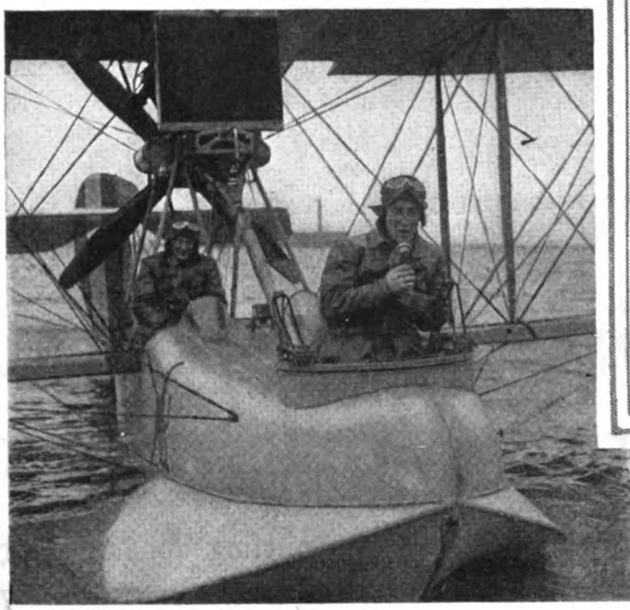
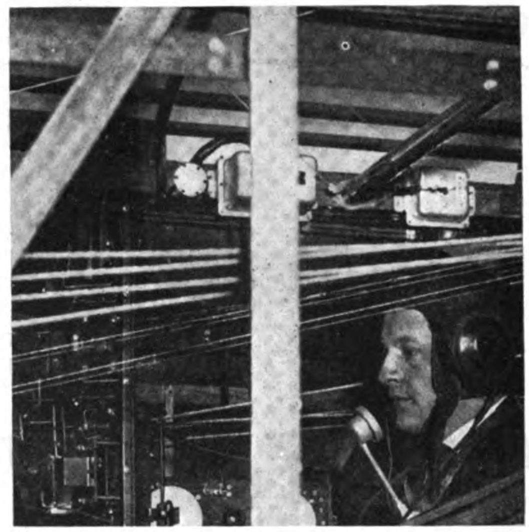
Aircraft Wireless

Photo: Press Ill. Svce. Photo: Keystone View Co.





To the left: Gunner H. Leaver at the wireless phone on one of the craft of the aerial coast patrol, which in peace time is employed in locating vessels in distress or in response to any coast alarm

Above: A close-up view of the U. S. Navy's latest flying boat, F-5-L, showing the radiophone installation and the operator

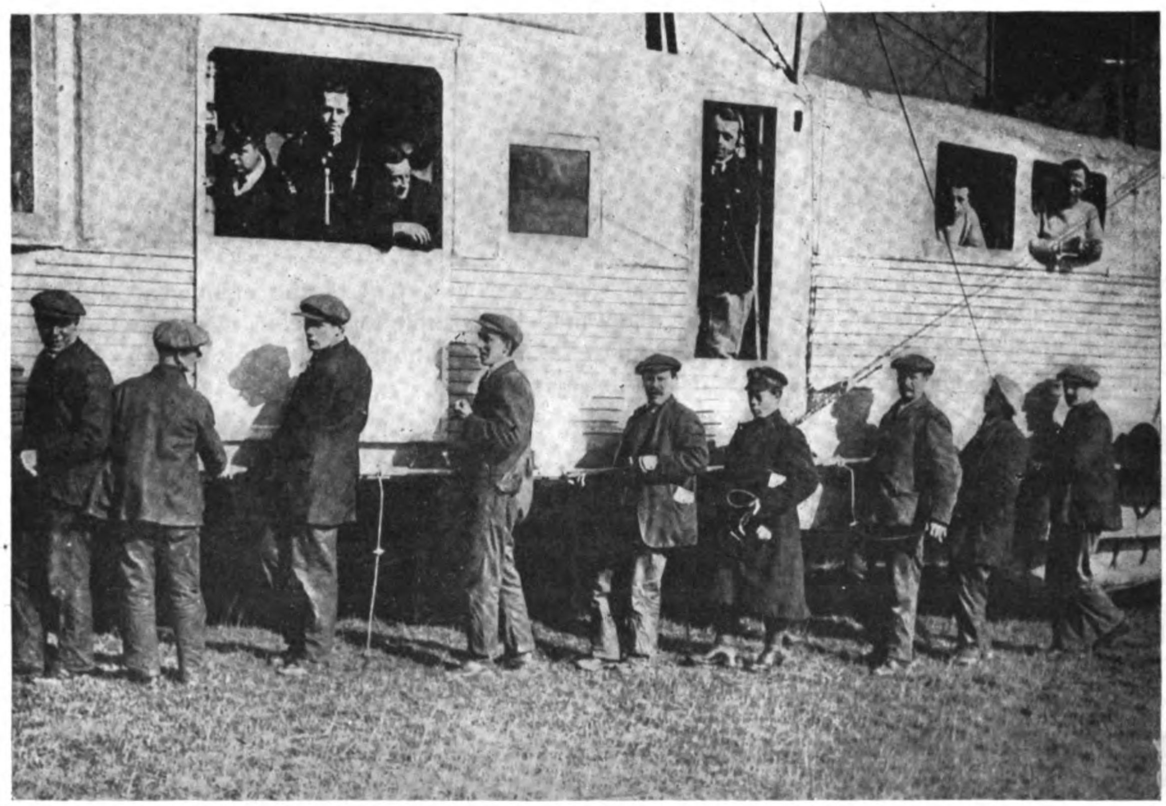


Photo: Intl Film

Launching the world's greatest airship in England; the operator may be seen at the door of the wireless cabin on the right

VOL. 6. No. 8. MAY, 1919

THE WIRELESS AGE

WORLD WIDE WIRELESS

Wireless Carries Voice Across the Atlantic

ROBERT WELLES RITCHIE, correspondent, was the first to make public the announcement that the human voice traversed the Atlantic at 7 o'clock on the morning of March 19.

After many months of preliminary experiments in long-distance telephony, a Marconi engineer in a wireless hut at Clifden, Ireland, at that hour, called "Glace Bay."

Instantly the answer came.

"Glace Bay talking."

From that moment on, continuously, Clifden communicated with Nova Scotia, the voices carrying strong and clear all day.

There were no sentimental speeches about the marvel of God's work, but the technical engineers talked about improvements of the system which thus carries man's voice across the Atlantic as readily as between New York and Hoboken.

"Our experiment was a complete success," said General Manager Bradfield, of the English Marconi Company. "Transmission was absolutely instantaneous, and the voices were as clear as over the telephone. After the first messages were exchanged, conditions were so perfect that our engineers continued their conversations all day, saving the delay of writing their comments and recommendations regarding improvements. I am sorry I am unable to give a detailed account at this time."

London first heard the news when Godfrey Isaacs, managing director of Marconi's Wireless Telegraph Co., Ltd., made the simple announcement at a dinner of the American Chamber of Commerce:

"Today we made experimental tests of wireless telephony between Ireland and Nova Scotia. They were completely successful. I look forward to the time, in the near future, when you gentlemen can talk to your home office as easily as with any London address."

Later, according to Mr. Ritchie, Marconi himself observed:

"Within three months you, from your hotel room in London, will be able to call any New York telephone number and get it inside of fifteen minutes, and then talk for three minutes for five dollars."

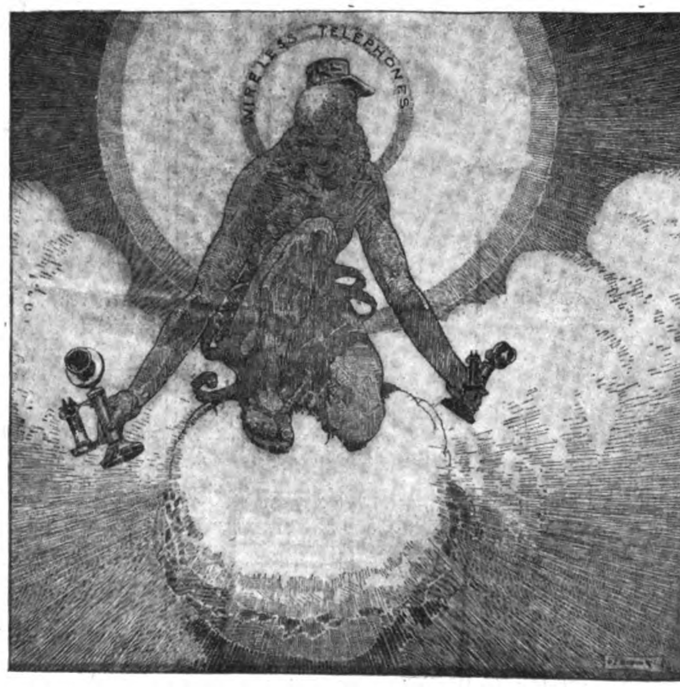
Though detailed information regarding wireless telephoning between Ireland and Canada is withheld for the present by the Marconi Company, the transatlantic wireless telephone promises to be an astonishing success and that the first efforts to talk through the air were much more successful than the first attempts at wireless telegraphing.

The establishment of a regular system of commercial wireless telephony from New York to London is believed to be now merely a question of time, and before long Sydney, Australia, and the furthest parts of the earth will be placed on the aerial exchange.

On March 20 the U. S. Navy Department also announced that one-way wireless telephone conversations were held between the Naval Radio Station at New Brunswick, N. J., and the American transport George Washington throughout her voyage from New York to Brest.

The messages were sent from the station at New Brunswick, erected by the American Marconi Company before the war, but which was taken over by the Government and has since been under naval operation.

The George Washington received wireless telephone messages and replied to them by wireless telegraph, not having a radiophone apparatus for sending messages over long distances. One of the messages sent by wireless telephone to the George Washington was from Secretary Daniels. President Wilson listened to the wireless words of Mr. Daniels but was unable to reply vocally.



The new messenger boy
—O. S. Williams in the N. Y. Journal

British Record in Technical Development Criticized in London

AN EDITORIAL in the London Electrician credits American inventiveness with many of the advances in wireless and takes England to task for her lack of contribution to the art on a scale of equality with other nations. In opposing control of radio by the British Government, the editorial observes:

"In view of the immense volume of progress in all branches of technology with which the private investi-

gator must be credited, it would seem that great harm would result from hasty decisions to debar him from wireless telegraphy. No amount of liberty for established firms could compensate for the extinction of the independent worker; in fact, his extinction would assist these firms to become great monopolies.

"Our national record in wireless telegraphy, apart from the finanacial side, is a sorry one. None of the new ideas that have revolutionized the subject during the past seven years can be regarded as having their origin or full development in this country. The conception of beat-reception is American. The three-electrode thermionic relay is American. The method of generating oscillations by aid of three-electrode relays was invented (probably independently) in Germany and the United States. The control of large high-frequency currents by magnetic relays is likewise of German and American origin. The multiplication of frequency by aid of the properties of iron is French, Italian and German. The success in high-frequency generation by alternators is American, French and German. Even the design of the valves which we used by

Wireless possibilities!
—Fay King in the N. Y. Journal

tens of thousands in the war is not native; we have been the humble copyists of the French in this, and, according to some accounts, second rate in that capacity. The theory of the operation of the circuits is mainly due to French and Italian perspicacity. Nearly all amplifier design and development is French and American. Our main successes in this subject during the war have been in the improvement in detail of wireless telegraph apparatus, and in this we may probably be credited with having done exceedingly well; but the fact remains that no novelties of the first order of importance arose in the work done in this country."

Photographic Recording Method to Speed Up Wireless Transmission

WIRELESS messages can be received and recorded at greater speed, as a result of a new photographic device now being used at the naval station at Otter Cliffs, near Bar Harbor, Me. Although the instrument is not immune from the effects of static "strays," it has successfully recorded messages at high speed regardless of strong static interferences that, without its aid, would have baffled the receiving operator. It is said that this machine has frequently recorded at the rate of 400 words per minute and, on one occasion, 600 words.

Up to this time the most rapid method of recording radio signals has been by dictaphone, but the phonographic method has never yet approached the rate of 600 words per minute, so the new instrument has hung up a new speed record.

Speedy sending and receiving can condense the traffic: a greater volume can be sent with a minimum number of stations. When it is remembered that a pair of wireless stations—one in Europe and one here—can easily cost $2,000,000, the item of keeping down overhead charges by rapid sending will be easily appreciated.

Expert operators have been known to receive thirty-five words per minute for a short time under perfect conditions, but average reception has been fifteen to twenty words per minute, or 1,000 words per hour.

The photographic recorder in operation at Bar Harbor has repeatedly recorded regular traffic schedules ranging from 1,000 to 7,000 words without interruption, and at a speed of forty to fifty-five words per minute every word is perfect and easily and quickly read. It is used supplementary to the ordinary type of receiving set.

The mechanism is based on comparatively simple electrical engineering principles. A lightweight mirror "flutters" in electro-magnetic tune with the minute electric impulses coming from the receiving antenna. The duration and extent of the mirror's oscillations vary according to the dot, dash, or silence of the sending station. This mirror reflects a beam of light on the moving sensitized tape. This tape, propelled by an electric motor progresses up and down through the vertical pipes which contain the developing and fixing chemicals. Automatically the tape enters the developing fluid and then the hypo fixing bath; then it is washed in running water and is dried by electric heat assisted by forced draft—all invisibly effected inside this single machine. Like the tape from a stock-ticker, the message pours out into a basket. In rapid receiving there is an average of one word for every inch of tape. The receiving operators can read the record at a speed of 50 to 100 words per minute.

The time to record, develop, fix, wash, and dry the tape is from two to four minutes. The rolls of tape are 1,000 feet long and a continuous message of 10,000 words can be recorded without reloading the machine.

Submarine Jazzes for Airship by Radiophone

OUT of the depths the strains of a popular tune were wafted through the air to the radio telephone apparatus at the Aeronautical Exposition in Madison Square Garden, New York, on the afternoon of March 7.

The lively tune came as a striking contrast to a conversation that had just been completed with the naval airship, L. S. B., flying over the city, navigated by Captain Noble E. Irwin, director of naval aviation.

A large crowd had gathered around the radio space at the Garden, attracted by the novelty of listening to a man talking aboard an airship floating in space three miles away.

In the airship Gunner Lever was telling the crowd in Madison Square Garden the interesting points the airship was passing, when a gruff voice impinged itself upon the oratorical tones of the aerial gunner. "Say," it said, "when are you fellows going to get through? This is the Submarine 249, in the North River, off Twenty-third Street. We are tired of listening to that voice. We are going to give you a tune for a change."

Then, to the astounded spectators the loud speaking telephone, which was being used for the demonstration, reproduced the newest dance music with all the flourishes of Lieutenant Europe's famous jazz band.

Predicts Business Conducted with South America by Radiophone

BUSINESS men of America soon may be placing and taking orders in South American ports by wireless telephone, Edward N. Hurley, chairman of the Shipping Board, told a conference of the Pan-American Union on March 14.

Outlining preparations that are being made to put new shipping in the South American trade, Mr. Hurley foresaw the time when business men of New York would be sitting back quietly in their offices talking with their clients in Buenos Ayres, Rio Janeiro and Valparaiso by wireless telephone as easily as one calls up a neighbor in New York.

Twenty-two 12,000 ton vessels are being constructed for the South American trade, Mr. Hurley said. They will be equipped as comfortably as the finest ocean going palaces which ply in the Atlantic. An additional twenty-two vessels of smaller tonnage are being built for the same trade.

Wireless Service to Holland Required by Cable Interruption

THE British Administrator announced early in March, through the Commercial Cable Company, that owing to the interruption of several wires in the cables to Holland an auxiliary wireless service has been provided pending completion of repairs. Messages intended for transmission by wireless, the announcement added, should be marked by senders "via wireless," and these words should be included in the service instructions. The rate is the same as by cable.

Wireless Guide for Transocean Fliers

LONDON advices relative to transatlantic flight state that at least one of the airplanes that will compete for the transatlantic flight prize will be navigated from wireless information, supplied every half-hour or so by British Air Ministry officials. The pilot will send out an inquiry, and from the direction from which his message is received wireless stations will calculate his exact position. This will be relayed by wireless to the pilot in a few minutes.

The British "Directional" wireless apparatus has been developed during the war, and the Air Ministry claims its instruments are far in advance of those of any other nation.

"Listening at their instruments in shore stations," said an English wireless officer, "hundreds of miles from the spot where an airplane is battling its way across the ocean, our operators will hear a short, prearranged code from the navigator at every coast station.

"Possibly a number of battleships will record the messages and instruments now perfected will point out in each instance the exact direction of the airplane.

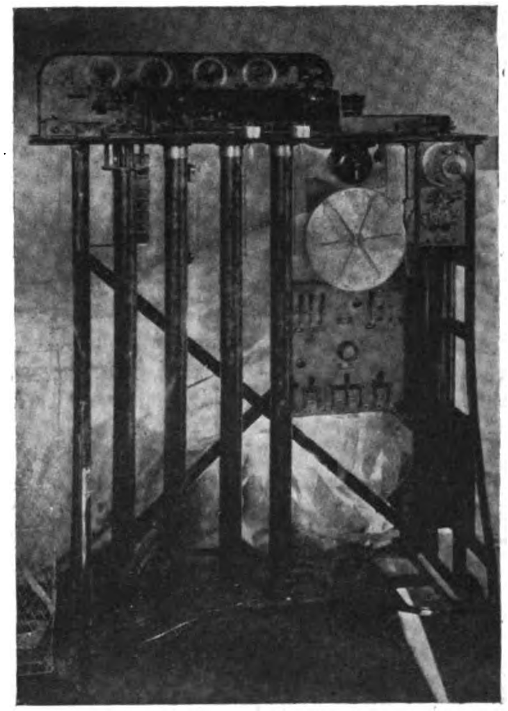
"There will be a hasty conference between the stations, and within five minutes the navigator will be able to mark on his map exactly what his position was when he sent his inquiry.

"Fitted with 'directional' wireless and a good compass the airplane will be able to steer through fog or clouds without getting more than a trifling distance off its course."

Canada also promises close co-operation so that aviators engaged in the transatlantic flights will never lose touch with their friends on shore. Friendly voices will advise them and their progress or difficulties en route will be reported in their own words and heard in their own voices by eager watchers. The Marconi wireless telephone will make this possible, says an announcement given out by Thomas Robb, of the Canadian Company. The flight will be made direct from the west coast of Ireland to Newfoundland. There are thirty Marconi stations on the west coast of Ireland and Scotland and an equal number around the central works at Gaspe Bay.

"We have the situation thoroughly in hand now," said Mr. Robb. "We have taken every precaution, so the risk to the aviators will be considerably modified. Through steamships on the ocean and land stations we will be in touch with them all the way.

"The airplane will have the wireless telephone and telegraph sets. The ship will have the wireless telegraph sets, enabling the aviators to receive news as to fog and weather and also be told where their exact landing place is. Newfoundland is a splendid wireless base, and the government there is co-operating with us."



Photographic device for printing wireless messages on tape with a speed of 400 words a minute

Method of Overcoming German Jamming Disclosed

POWERFUL German wireless installations were used to drown out messages among the Allies as part of a deliberate policy. How our navy, on entering the war, overcame this interference was described by E. F. W. Alexanderson at the April meeting of the Institute of Radio Engineers. An abstract of his paper appears elsewhere in this issue.

Dr. Alexanderson described his device as a "barrage receiver," which permits an operator to turn a deaf ear, electrically as well as literally, to all messages which may come through the ether except that particular message which he desires to hear. The invention was kept secret until the end of the war at the request of the army and navy. It has been demonstrated successfully and is now in navy use.

"The object of this development," said Alexanderson, "was to provide means for neutralizing the overwhelming intensity of the transmitted signal so as to make the receiving set sensitive to the faint impulses of the distant signal. Popularly speaking, the correspondent equivalent in sound waves would be to have an ear which could be so adjusted that a person could stand close to a steam whistle without hearing the whistle, but at the same time listen to a person speaking from a distance of a few hundred feet."

Bogota to Have Powerful Marconi Station

ANOTHER COMMUNICATION link with South America has been announced by the State Department at Washington. Marconi's Wireless Telegraph Company, Ltd., of London, the report states, has concluded a contract with the Colombian Government for the erection of a powerful wireless station at Bogota.

Millionaire's Ranch to Use Wireless and Airplane

J. PIERPONT MORGAN has engaged Erhardt Schmitt of Ansonia, Conn., to pilot the manager of his 250-mile tract of wheat fields at Hardin, Mont., in an airplane. Thus Mr. Morgan solves the problem of getting speedily to any part of the ranch. It is believed Schmitt will be the first man to pilot an airplane as agricultural equipment. The airplane will be equipped with wireless, and stations will be established at intervals on the ranch.

On a ranch the size of Mr. Morgan's it was impracticable to build roads to enable the manager to get around the ranch in an automobile, so the owner adopted the airplane, which will save much time and undoubtedly will prove to be less expensive.

Mr. Schmitt is a wireless operator, and so the manager will be able to keep in touch with every section of the territory. Mr. Schmitt was discharged recently from the United States Army. He was a First Lieutenant in the American Air Service in France.

Time Signals Changed on Schedule

IN accordance with the daylight saving law, daily telegraphic time signals are now sent from the United States Naval Observatory at noon Washington summer time, i. e., at four hours Greenwich mean time.

Daily noon and night radio time signals are sent from naval radio stations on the Atlantic coast at four hours and fourteen hours Greenwich mean time (noon and 10 p. m. Washington summer time), except Washington, which will remain, as formerly, five hours and fifteen hours Greenwich mean time (1 p. m. and 11 p. m. Washington summer time), and from the stations on the Pacific coast at seven hours and seventeen hours Greenwich mean time (noon and 10 p. m. San Francisco summer time).

Only American Paper in Germany Has Wireless News Service

SOLDIERS of the Fourth Army Corps are responsible for the "Only American Newspaper Published in Germany," as The Fourth Corps Flare is proclaimed, being published at Mayen every Friday, with wireless news from all parts of the world up to the time of going to press.

The biggest headlines, according to a dispatch from Coblenz, are devoted to speculation as to when the return trip to America will be made, and news of the Peace Conference, interior happenings in Germany, of the United States, France and England, is picked up from the air as needed to complete each edition.

The editor of the Flare is a well known amateur, Wallace W. Smith, of the Radio Club of Louisville, Ky., now a Second Lieutenant with the A. E. F.

Doctors Aboard Troopships Consult by Wireless

ANOTHER instance of the practicability of diagnosis, treatment and medical consultations by wireless at sea was recorded in the westward passage of two transports early in March.

Sierra in mid-ocean received a wireless telegraph message from the captain of the British steamship Pollac, saying that a member of his crew had been taken sick suddenly. The message gave symptoms and asked for diagnosis and treatment. Further messages brought a clearer knowledge of the case to Lieut.-Commander A. E. Younie, of the Medical Corps of the army, chief surgeon aboard. Treatment was ordered and hourly reports were made by the captain of the merchantman to the doctor a hundred miles away. In two days the man had showed marked improvement, and when last reported was recovering rapidly.

The wireless telephone was also used for a consultation of all the doctors aboard the Sierra and those aboard the Powhatan, another troop transport. The two vessels were fifteen miles apart, at a point about five hundred miles north of the Azores, when a consultation about influenza cases developed on the Powhatan was determined on. Six doctors, via wireless telephone, "attended" the conference, the cases being discussed as freely as if the physicians were gathered in one room.

"It doesn't take much imagination to see what a wide field of possibilities the wireless opens up to the medical profession," Lieut.-Commander Younie said. "America is building up an enormous merchant marine. The greater portion of the ships will not be large enough to carry doctors, but in an emergency the captain of one of these ships, using her wireless set, can always call upon expert medical advice, either from ashore or from the doctors aboard the larger ships."

Liberian Station at Monrovia No Longer German

LIBERIA has advised the American Government that the former German wireless station at Monrovia has been opened with a Liberian staff for general public service.

Canadians Install Commercial Wireless Telephones

THE wireless telephone is to be put to practical commercial use in Canada.

Instruments are being installed in the offices of the Montreal Board of Trade and these will enable brokers to talk with Kingston, Ottawa, Three Rivers and Quebec.

It is expected that ultimately conversations will take place between the Board of Trade and Ireland over the Marconi Company's wireless.

Eight Radio Compass Stations for New England

THERE will be eight radio compass stations established along the New England coast, according to a statement made by Rear Admiral Spencer S. Wood. Deer Island station has been repaired and made over. North Truro on Cape Cod and Otter Cliff, Me., are working.

Argentina and Paraguay Make Radio Exchange Agreement

THE Governments of Paraguay and Argentina will exchange radio telegraphic service. An agreement has been signed by the respective representatives of the two Governments. Wireless telegraphic communication is a government monopoly in both countries, and it is hoped that the arrangement will result in much better service for Paraguay than it has enjoyed heretofore.

Naval Operators to Be Taken Off Merchant Ships

GOVERNMENT wireless operators will be removed from all merchant vessels as soon as the ships are returned by the shipping board to their owners, is the announcement made by the hydrographic office at the Maritime Exchange upon the receipt of a communication from the Navy Department.

The apparatus was installed by the Navy Department and will be permitted to remain intact on the vessel for a time, but private interests operating the boat must furnish their own operators. If, however, the company is unable to maintain service, they may employ the navy operators until efficient ones can be had.

A Magnetic Detector of Radio Frequency Oscillations

CLAIMING to have discovered that the super-position of a high frequency current upon an iron core already excited by a low frequency current, reduces the area of the hysteresis loop for the low frequency current, G. W. Elmen has recently disclosed the circuits of a wireless receiving system based upon this principle. His explanation of the phenomenon is that the high frequency oscillations seem to shake up the iron molecules, thereby reducing the force required to set them into motion. Low frequency energy is thus saved, for the energy required to agitate the molecules is supplied by the high frequency source.

Currents of very high frequency are not necessary to carry out the principle of Elmen's receiving system, for it has been found that if low frequency current of approximately 15 cycles per second is employed, another current of 60 cycles per second is sufficient to cause the reduction of the hysteresis loop on the low frequency side to practically zero. If the current of lower frequency is then increased, the high frequency current must be increased correspondingly, and may be made very much higher than the lower frequency.

By selection of suitable iron and properly constructing the coil Mr. Elmen claims it is possible to make the ohmic and eddy consumption losses so small that they will be wholly due to hysteresis, thereby enabling the most effective results to be secured from the system.

In magnetic oscillation detectors use has heretofore been made of the suddenly induced effects produced in a receiver circuit when the hystersis cycle in a body of iron is brought partially or wholly into phase with the magnetizing force by the received high frequency oscillations. This sudden breaking down of the magnetic condition gives a sharp click or signal in the receiver or translating device which is independent of the frequency of the low frequency magnetizing force. Mr. Elmen's method of reception differs, in that he makes use of the change in the hysteretic energy which must be supplied by the low frequency source when high frequency oscillations are received. Since the change in hysteretic energy is equivalent to a change in the effective resistance of the coil surrounding the iron, any method for indicating or measuring this change in effective resistance may be employed to detect the presence of the radio frequency current. Accordingly, the inventor makes use of Wheatstone's bridge as shown in figures 1 and 2.

Figure 1 shows one circuit for detecting radio frequency currents; figure 2 is a modification, and figures 3 and 4 show forms of coils which have been found useful.

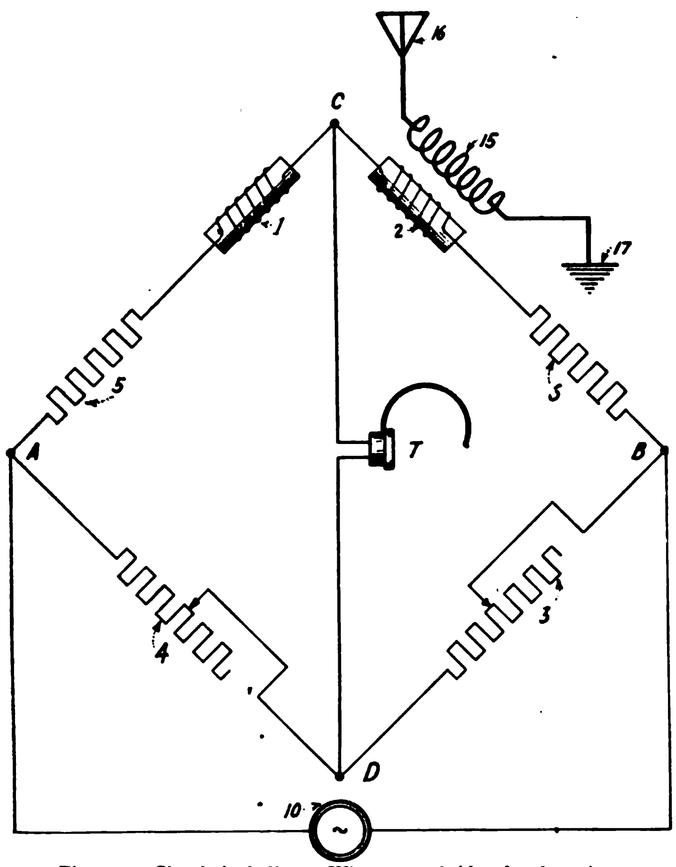


Figure 1—Circuit including a Wheatstone bridge for detecting radio frequency currents

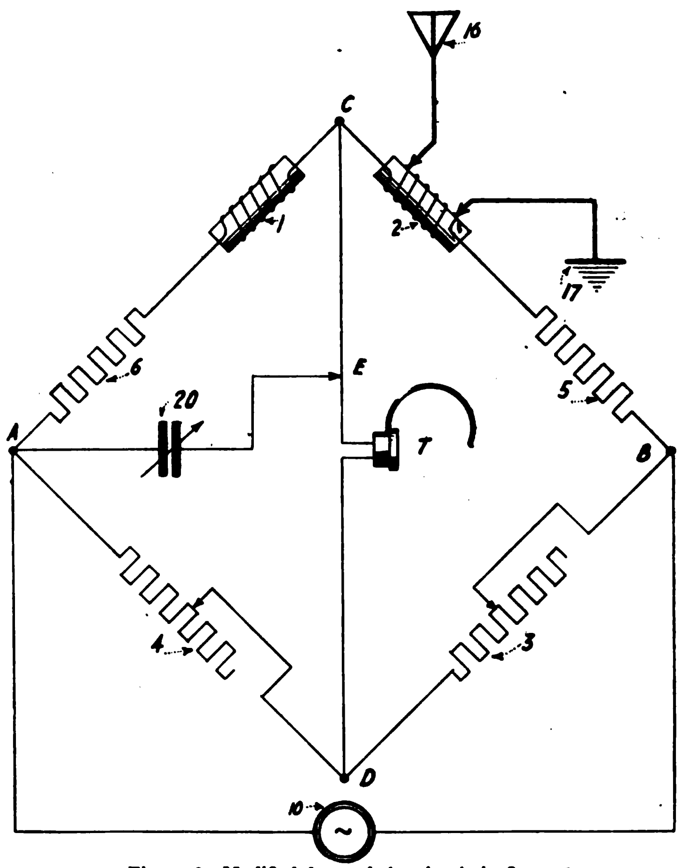
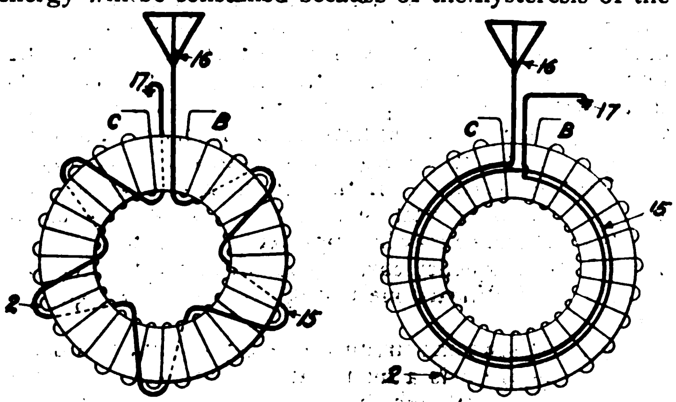


Figure 2—Modified form of the circuit in figure 1

In figures 1 and 2, the iron core coils 1 and 2 are made as nearly identical as possible, and of such form that the ohmic and eddy losses are very small. The cores should be of low coercive force and high remanence. The two other arms of the bridge contain non-inductive resistances 3 and 4 which should be adjustable. Connected to the terminals of the bridge A and B, is the source 10 of alternating or pulsating current of low frequency. Across the terminals CD are connected the head telephones T. Inductively connected to the coil 2 is the coil 15 which is the inductance element of the antenna current.

The circuit in figure 1 operates as follows: The bridge is balanced both for ohmic resistance and for reactance, so that no current flows through the phones T. In order to assist in this adjustment it may be desirable to place the non-inductive resistances 5 and 6 in the branches contain-

ing the coils 1 and 2, but these will not always be necessary, for if the coils 1 and 2 are made as nearly identical as possible, any slight difference in them can be adjusted by means of the resistances 3 and 4. Under these conditions, low frequency oscillations will pass continually through the network, and the iron cores of the coils 1 and 2 will be caused to pass through a magnetic cycle, and energy will be consumed because of the hysteresis of the



Figures 3 and 4—Coils used in the Elmen magnetic detector

iron. Since the bridge is balanced, however, no current will pass through the translating device T.

When high frequency oscillations are impressed upon the coil 2 by means of the antenna coil 15, the magnetic condition of the core of this coil will be suddenly brought into phase, wholly or partially, with the magnetizing force. As a result the bridge will be thrown out of balance and an indication will be given at T. In general this lack of balance is due to two factors, the first of which may be designated as e_1 and is due to the change in the flux in the coil 2, giving rise to a sudden induced electromotive force, which causes a flow of current through the telephone T. In addition to this effect there is a second effect which may be designated as e_2, and is due to the reduction in the hysteretic energy absorbed as a result of the hysteresis cycle through which the iron is carried by the low frequency source 10. This reduction in the amount of the hysteretic energy represents a reduction in the amount of energy which is consumed in the coil 2, and is therefore equivalent to a reduction in the effective resistance of the coil. This change in effective resistance produces a lack of balance in the bridge, and consequently there is a flow through the translating device T of current from the source 10.

It will be noticed that the first effect e_1 corresponds to the effect which is ordinarily made use of in magnetic detectors as heretofore constructed, and that the effect produced in T is simply a sharp click due to the sudden induced electromotive force. The second effect e_2, however, is independent of this, and is due to a lack of balance in the bridge, as a result of which there will be heard in the telephone receiver T a note which corresponds to the frequency of the generator 10, which will be heard as long as the coil 2 is subjected to the high frequency oscillations impressed upon it by the antenna.

Any other network which is adapted to measure inductances may be used in this system. An example is shown in figure 2, in which a variable condenser 20 is connected from the point A to some point E on the branch CD, which in this case has a small resistance. The bridge is brought into balance either by an adjustment of the capacity 20 or by an adjustment of the point of contact E. Having brought the bridge into balance, no current from the generator 10 will flow through T, but upon the receipt of high frequency oscillations, the bridge will be thrown out of balance and a signal will be received at T.

In order to obtain low coercive force and high remanence, it is desirable to use for the two arms of the bridge a closed core, as shown in figures 3 and 4. Furthermore, in order to reduce the eddy currents, these cores should be laminated or stranded. In figure 3 the high frequency coil is shown as wound upon the core in the same manner as for the coil 2. In figure 4 this antenna or high frequency coil is shown as being wound parallel to the core and preferably embedded in its center. It has been found that in this case the effect of the high frequency oscillations in reducing the hysteresis loss is as effective as in the coils shown in figure 3. Furthermore, it will be noticed that in figure 4 the coil 15 is at all points at right angles to the coil 2, and in consequence there is no induced effect of the coil 15 upon the coil 2.

The frequency of the generator 10 may be varied between wide limits. If the translating device T is to be the ordinary telephone receiver, then it is obvious that the frequency should be within the limits of audibility, and in this case a frequency of about 800 is very good indeed. If the translating device is a vibration galvanometer or some such device, the frequency may be made either lower or higher than the limits of audibility, this being determined by the frequency for which the device is adapted to be used.

Negative Resistance Vacuum Tube as an Amplifier and a Beat Receiver

FULL description of the pliodynatron devised by A. W. Hull appeared in the June and August, 1918, issues of THE WIRELESS AGE. Although this detector has not been employed commercially, it involves certain operating characteristics which have aroused considerable interest and incidental argument amongst wireless engineers. Numerous circuits have been devised, but Mr. Hull declares that those shown in the accompanying figures 1 and 2 give very marked amplifications and selectivity and, furthermore, permit the reception of continuous oscillations by the so-called heterodyne principle.

Throughout a certain range of adjustment, the Hull tube acts as a true negative resistance. An externally applied E.M.F. under proper adjustments of the tube will actually set up a current in the circuit in the reverse direction.

The circuits shown contain an inductance and capacity in the negative resistance circuit, making it resonant to the frequency of the incoming signal, with the result that when the incoming oscillations are impressed upon the grid or controlling circuit, the value of the negative resistance will change so that similar oscillations are produced in the local circuit. This results in amplification and marked selectivity. An audio frequency tuning circuit is provided which affords additional tuning means; and through the medium of a resistance 18 of figure 2, sufficient energy is transferred from the circuit containing the negative resistance to the control circuit to compensate for the losses in that circuit and the antenna circuit.

The heterodyne effect is obtained by causing the circuit containing the negative resistance to oscillate at a slightly different frequency from that of the incoming signal.

In the diagram, 6 is a filament cathode surrounded by the grid or controlling member 2; 4 is the so-called anode and 5 a third electrode which is connected to the positive terminal of a battery 8.

In the operation of this device a definite positive potential is applied to the anode 4 by means of a battery 7,

the cathode being considered as at zero or earth potential. When the cathode is heated to incandescence, electrons flow from the cathode to the anode. If the third electrode 5 is at the same potential as the cathode no electrons will be received by it, but if a small positive potential less than that of the anode is applied to the third electrode, a portion of the electrons will pass through the anode and reach the third electrode.

The velocity with which these electrons will strike the third electrode will depend upon the potential between it and the cathode. If this potential is increased, the velocity will increase until the electrons, striking the third electrode, are able, by their impact, to liberate secondary electrons. These secondary electrons leaving the third electrode will be attracted to the more positive anode. As the potential is increased, a point will be reached at which the number of secondary electrons leaving the third electrode will begin to decrease. As the potential of the third electrode is increased beyond this point, the current will continue to decrease and *may even reverse* in direction up to a point where the potential of the third electrode approaches that of the anode. Thus it will be apparent that the device has a working range through which it has a negative resistance characteristic; that is, over which the current in the external circuit, between the cathode and the third electrode, varies inversely as the potential between the electrodes.

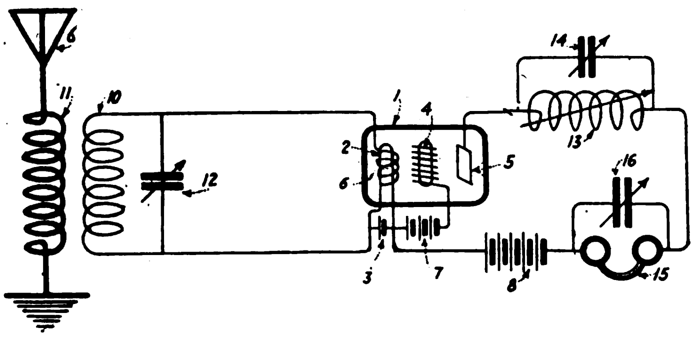


Figure 1—Circuit using the heterodyne principle to secure increased amplification and selectivity in receiving

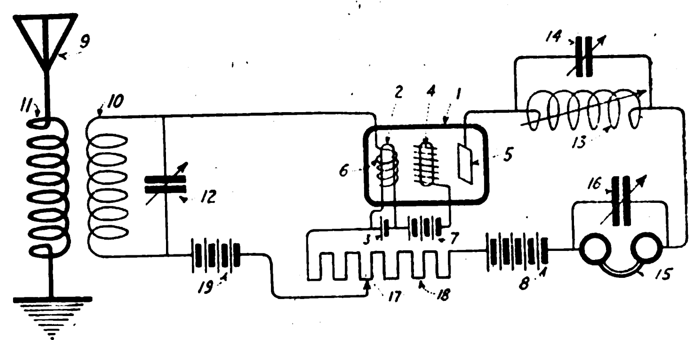


Figure 2—Another form of figure 1 which permits reception of continuous oscillations by the heterodyne principle

If a constant potential is applied to the third electrode, by means of the battery 8, of such value that the device will operate as a negative resistance, there will be a constant flow of current in the external circuit. If, however, a variable potential is applied between the cathode and the discharge controlling member 6, the number of electrons which leave the cathode and reach the third electrode will be varied, and the current in the external circuit will be varied accordingly; that is, if the member 6 is made more positive, the flow of electrons to the third electrode will increase, and if the member 6 is made more negative, the flow of electrons will decrease and a small change in the potential of the member 6 will be capable of producing a large change in the current between the cathode and the third electrode.

In utilizing this device for the reception of wireless signals, waves which are received upon the antenna 9 are impressed upon the discharge controlling member 6 by means of an oscillating circuit comprising an inductance 10 which is coupled to the antenna inductance 11 and a variable condenser 12. In the external circuit between the cathode and the third electrode are placed a variable inductance 13 and a variable capacity 14 in parallel. This circuit may include the usual telephone receiver 15 shunted by a variable condenser 16.

In receiving signals, by this system, the inductance 13 and capacity 14 may be so adjusted that the circuit is capable of oscillating at frequency equal to that of the received signals. The value of the negative resistance is adjusted to such a point that the circuit is near a point of instability or a point where oscillations will begin. When the potential of the member 6 is varied by received oscillations, the value of the negative resistance will be changed sufficiently so that the circuit will start oscillating. Under these conditions the amplification of the received signals will be assymetric and the resulting current will operate the telephone receiver.

Without the condenser 16, the circuit would tend to produce oscillations of an undesirable audio frequency. This condenser 16, however, may be so adjusted as to prevent the setting up of audio frequency oscillations, or may be so adjusted as to produce audio frequency oscillations of a frequency equal to the group frequency of the incoming waves. The final adjustments of the system may conveniently be made by varying the value of the negative resistance, which is done by regulating the temperature of the cathode 2.

In order to secure the highest degree of amplification in the system described, the positive resistance of the circuit should be approximately equal in value to the negative resistance.

In the arrangement shown in figure 1, the negative resistance compensates for the losses in the positive resistance of the circuit between cathode and third electrode. In the modification shown in figure 2, means are indicated for compensating also for the losses in the resonant receiving circuit and the antenna. In this case the discharge controlling member 6, instead of being connected directly to the cathode 3, is connected to a suitably selected point 17 on the resistance 18, which is in series with the negative resistance. The voltage supplied to the device by the battery 8 is of such a value that the current in the circuit is negative; that is, positive electricity or its equivalent flows from cathode 2 to the third electrode 5 across the evacuated space and thence through the battery 8 and resistance 18 back to the cathode. If the potential of member 6 is made more positive, the current through the resistance 18 will increase, and thus the potential of the point 17 and of the member 6 will be still further increased. By means of this resistance coupling, energy is fed back from the negative resistance circuit to the resonant receiving circuit and by properly adjusting the point 17, the amount of energy thus transferred may be made sufficient to compensate for the losses in the receiving circuit and in the antenna without producing oscillations.

An anonymous donor has deposited with the Institute of Radio Engineers, New York, the sum of $10,000, the principal to be preserved in perpetuity and the income each year to be awarded to that member of the institute who shall have made the most important contribution to the art of radio during the preceding year. This, in addition to the Institute's Medal of Honor, should spur forward American students in the radio field.

Exhausting Vacuum Tubes

Readers of The Wireless Age who are identified with the manufacture of vacuum tubes may be interested in the process of evacuation devised by H. D. Arnold. The method shown in figure 1 provides particularly for heating the exterior of the tubes during the exhausting process; also for heating one or more of the inclosed electrodes by the passage of an electric current and also for heating another electrode by electronic bombardment due to the application of a local E.M.F.

In the drawing, figure 1, thermionic repeater elements 2, each having the customary filamentary cathode 3, grid 4 and anode 5, are inclosed in an oven 6 which may be electrically heated by a resistance element 7 connected to a source of current 8. The glass containing vessels 9 of the elements 2 have tubular extensions 10 connected to a main tube 11 leading to an exhaust apparatus 12, such, for example, as a Gaede molecular pump, connected to a source of motive power 13. The terminals of the electrode elements 3, 4 and 5 are brought out through apertures in one of the walls of the oven 6, so as to be readily available for test purposes and for the application of any desired electromotive force.

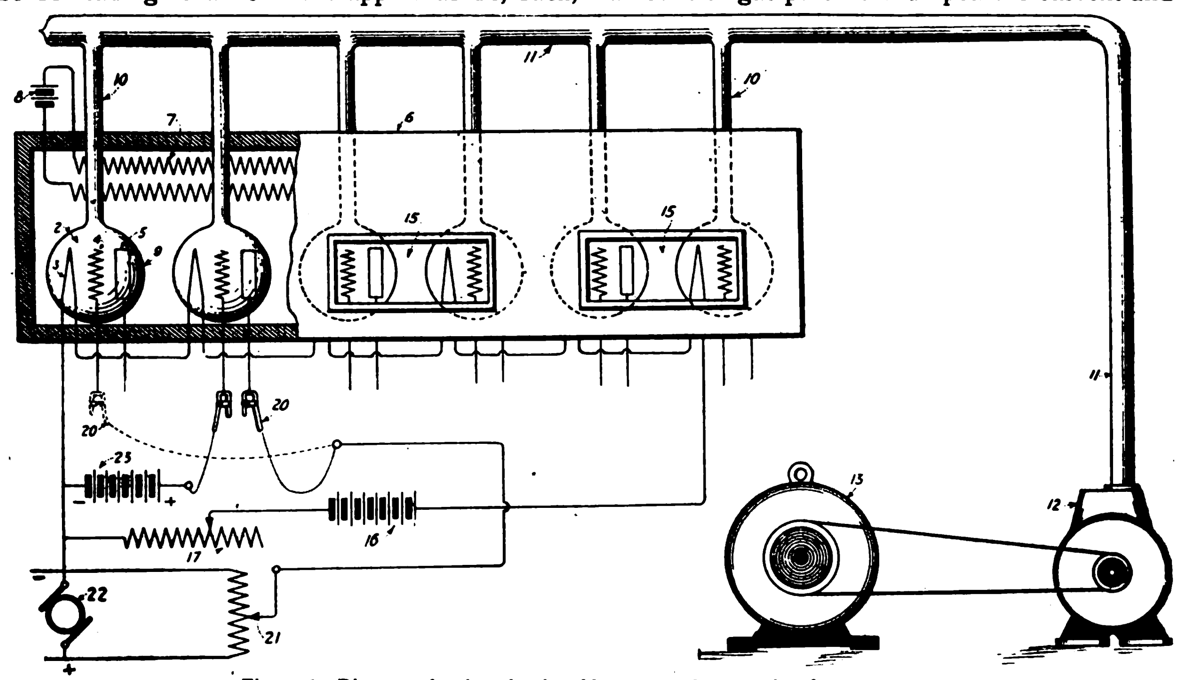


Figure 1—Diagram showing the Arnold process of evacuation for vacuum tubes

A suitable number of windows 15 are provided in the front of the oven 6 so that the tubes 2 being exhausted may be observed during the evacuation process. The filaments 3 are connected in series with a source of current 16 and a variable resistance 17.

The process of exhausting the vessels 9 is as follows: The pump 12 is started and the temperature of the oven 6 is gradually raised until it has reached approximately 350° C. The purpose of this heating is to drive out the gases occluded by the walls of the vessel 9. After the temperature of the oven has risen to about 250° C., the filaments 3 are brought to incandescence by current supplied from the source 16, which is raised to a value approximately 10 per cent greater than the current normally to be used in the operation of the completed device. A potential difference is thereupon successively applied to the terminals of the electrodes 4 and 5 by means of a test clip 20 connected through the potentiometer 21 to a direct current source 22 of about 220 volts output. The filament 3, being connected to the negative terminal of the source 22 as shown, and the test clip 20 being connected to the positive terminal of the source 22, there will result an electron discharge from the cathode 3 to the electrode 4 or 5, to which the test clip 20 is temporarily connected. This potential difference is made sufficiently high, through adjustment of the potentiometer 21, to cause an electron discharge of sufficient volume to heat the electrode (to which the test clip 20 is attached) to incandescence. This drives out any gases which may be occluded by the electrode.

The electron discharge, which passes from the cathode 3 to either electrode 4 or 5 when a potential difference is established between them, partially ionizes whatever gas may be in its path. When gas in sufficient quantity is thus ionized, a blue glow results in part or all of the vessel 9, which may readily be observed through one of the windows 15. The intensity of this blue glow depends upon the amount of gas present and upon the current and potential difference impressed between the cathode 3 and electrode 5. For a given current and potential difference, therefore, this blue glow will gradually become fainter as the gas within the vessel becomes more attenuated, until the glow finally disappears.

When the proper degree of exhaustion is obtained, the tubes are allowed to cool gradually and are sealed off of the pump 12 and given an aging run. This consists of applying the normal heating current to the filaments 3 and impressing the customary operating potential difference between the cathode 3 and anode 5. It has been found that after an aging run of from fifteen to twenty hours duration the repeaters have reached a stable condition and may be relied upon to give constant and uniform results.

In case the thermionic device to be exhausted is equipped with a grid 4 of very fine mesh, as in the case of a repeater tube designed for voltage amplification, it may be difficult to obtain a current to the electrode 5 sufficient to heat it properly. In such event, it has been found desirable to apply an additional positive potential from a source 23, for example, of perhaps 60 volts output, to the grid electrode 4 at the same time that the positive potential from source 22 is being applied to the anode 5. This increases the flow of electrons to the anode 5, and as some current will also flow between the filament 3 and grid 4, the voltages may be adjusted so as to heat both electrodes 4 and 5 at the same time.

Langmuir's Mercury Vapor Modulator for Wireless Telephony

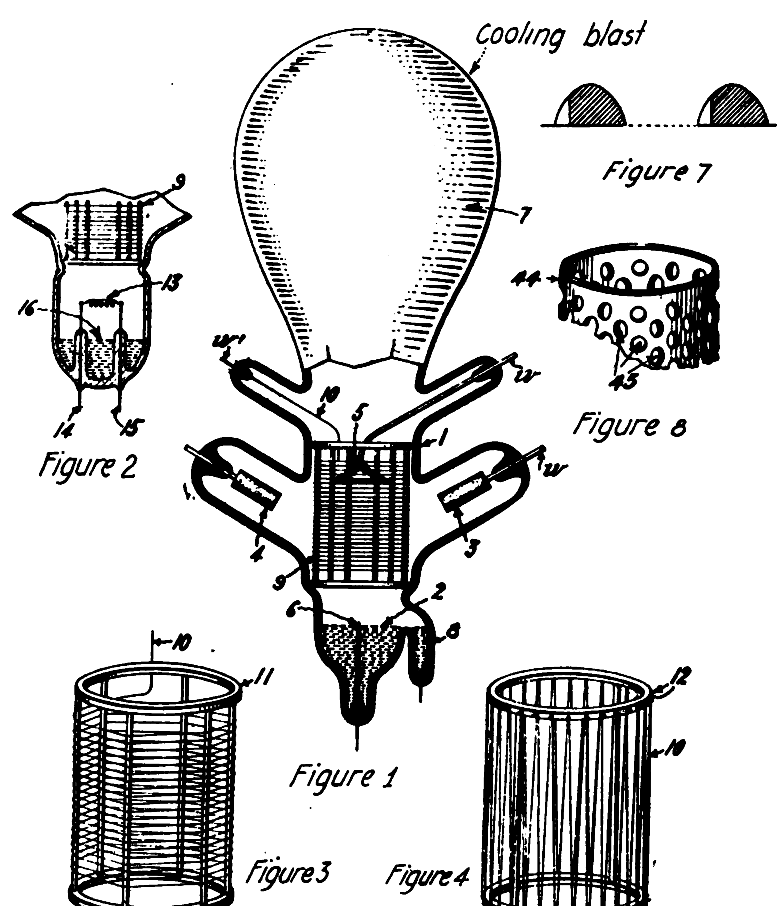
A METHOD of controlling the output of a radio frequency alternator at speech frequencies for radio telephony is the subject of a recent patent granted to Dr. Irving Langmuir. The control device illustrated in figure 1 comprises a glass or quartz envelop 1 containing a body of mercury 2 (constituting the cathode), and main anodes 3 and 4 which may be made of graphite, tungsten, molybdenum or other highly refractory material.

Above the cathode 2 is an anode 5 from which a constant arc is formed with the cathode. The steadiness of the arc is insured by the conductor 6, of platinum or copper projecting above the surface of the mercury. A condenser chamber of the correct size to give the proper mercury pressure is shown at 7. The arc is started by the small electrode 8; 9 is a grid of tungsten wire placed between electrodes 5 and 2 and the anodes 3 and 4. Suitable constructions for the grid are shown in figures 3 and 4. Figure 8 shows a modified form.

Two circuits for wireless telephony are shown in figures 5 and 6. In figure 5 energy is withdrawn from the antenna at speech frequencies; in figure 6 modulated currents are supplied to the antenna from the radio frequency alternator.

In figure 5 the usual antenna 17 is shown containing an inductive coil 18 and a series condenser 19. Electrical energy is supplied by a high frequency alternator inductively coupled to the antenna coil 18. The coil 22 is also located in inductive relation with the coil 21 and has its terminals connected by conductors 23, 24, to the anodes 3, 4 of the control device. The cathode 2 is connected in series with the resistance 25 by a circuit conductor 26, carrying rectified current, to a point of intermediate potential on the coil 22. The circuit represented by conductor 27 connecting the cathode 2 and the anode 5 contains a battery 28 for supplying energy to continuously maintain an arc between these electrodes. This same battery may also be used to start the device by completing a circuit to the auxiliary electrode 8 through the switch 29.

When the arc between the electrodes 5 and 2 is normally operating, energy is supplied by the alternator 20, and successive arcs would ordinarily pass from the anodes 3 and 4 to the cathode in the usual manner. When, however, the grid 9 is negatively electrified to a sufficiently high potential the starting of these arcs is prevented. In order to take advantage of this fact a variable negative potential may be impressed upon the grid, thereby causing variable amounts of energy to be passed by the arc device. As this energy is consumed in the resistance 25, it is subtracted from the energy available for the antenna. In this way signals may be transmitted. For example, a telephone transmitter 30 containing a local source of energy such as battery 31, may be connected to the primary of a transformer 32, the secondary of which is connected to its negative terminal by the conductor 33 to the grid 9. The positive terminal of the secondary is connected by a conductor 34 in series with the battery 35 to the cathode 2. The battery 35 is not absolutely essential, but is desirable as it maintains the grid at a definite negative potential so that the variations impressed by the signaling current vary the grid potential to values above or below the battery potential.



Detailed diagrams of Langmuir's mercury vapor modulator for wireless telephony

High frequency current in the circuit 33, 34 is damped out by a condenser 36 and the resistance 37. When a voice produces variation in the conductivity of the transmitter 30 the resultant variable current in the transformer 32 is stepped up in potential, superimposed upon the battery potential 35 and thus varies the charge on the grid. The grid, in accordance with the degree of its negative charge, delays the starting of the wave impulses from the anodes as shown diagrammatically in figure 7, the shaded portions of the waves indicating the energy transmitted through the control device.

Instead of withdrawing energy from the antenna by the control device, it may be directly transmitted to the antenna from the high frequency source through the control devices, as shown in figure 6. In this figure the high frequency alternator 20 is connected with the primary of the transformer 38, the secondary of which is connected by conductors 39, 40, to the anodes 3, 4 of the arc control device. The cathode 2 is connected by a conductor 41 in series with the primary of a transformer 42 to a point of intermediate potential of the transformer 38. The other connections of the control device are similar to those already described. When a variable potential is impressed on the grid 9 by the telephone 30, variable portions of the wave impulses from the high frequency supply are transmitted by the arcs and impressed as rectified current impulses on the transformer 42, the secondary of which is included in series with the antenna 43. A high frequency

current having double the frequency of the source 20 is generated in the antenna, varying in accordance with the variations of the signaling current.

It would be of interest to know whether this device operates without distortion. It is not quite clear that it will give as effective modulation as the 3-electrode vacuum tube.

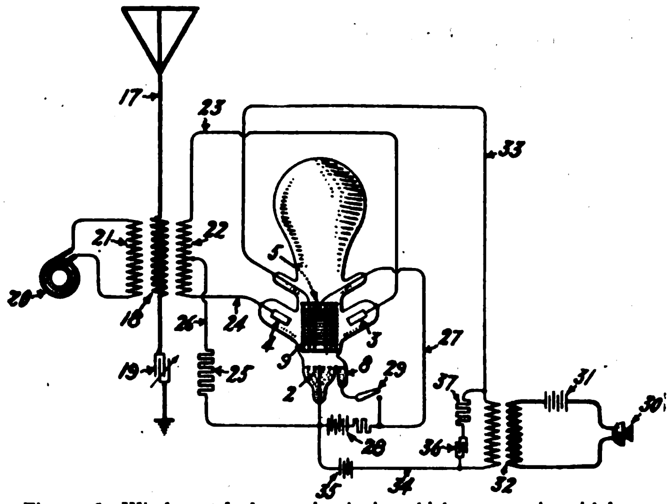


Figure 5—Wireless telephone circuit in which energy is withdrawn from the antenna at speech frequencies

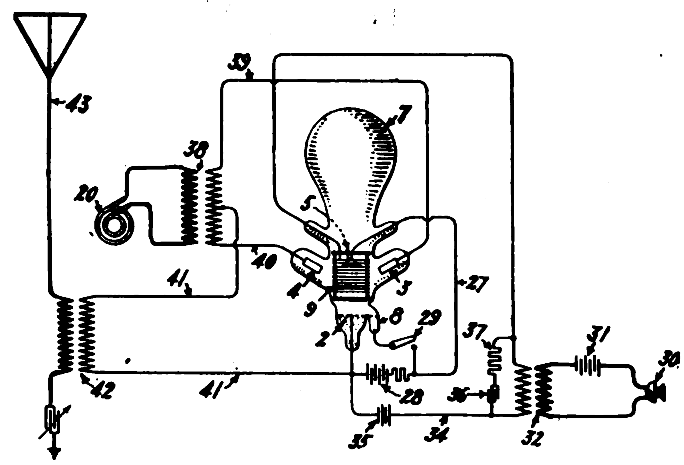


Figure 6—Circuit for wireless telephony in which modulated currents are supplied to the antenna from the radio frequency alternator

Receiving Antenna

THE accompanying diagrams illustrate a specially constructed aerial designed to block out waves or disturbances of a frequency differing from the one which it is desired to receive. The antenna construction is the joint invention of Roy A. Weagant and Harry Shoemaker. They have observed in the average case that resonance adjustments of the receiving aerial are well defined for any particular frequency being received, yet oscillations of other frequencies emanating from near-by powerful transmitters may set the receiving antenna into oscillation uniformly distributed capacity and inductance to a condition of non-uniform distribution.

Such an arrangement of inductance with a capacity in parallel, connected in series in an antenna circuit, has a very high impedance to electrical oscillations with a time period which is the product of the localized inductance and capacity. If the resistance of these lumped circuits was zero, their impedance would be infinite; but by keeping the resistance small, the impedance will be sufficiently large to effectively block out interfering frequencies.

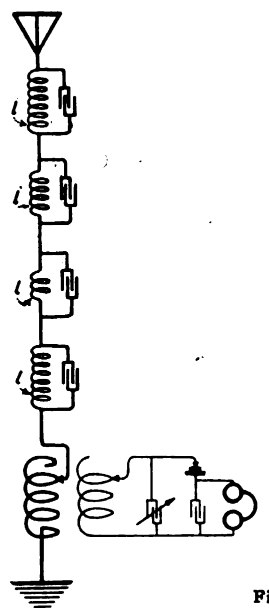


Figure 1

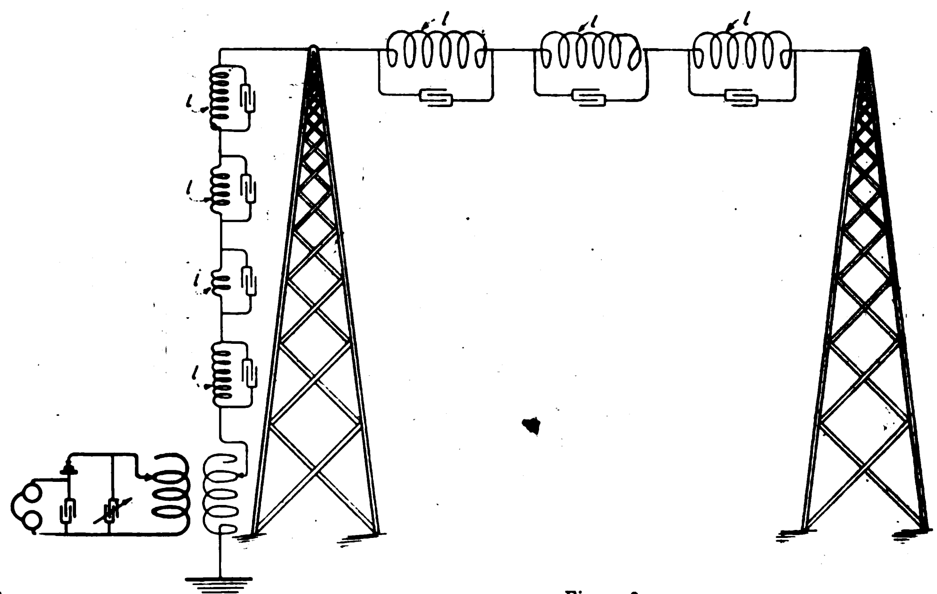


Figure 2

Diagrams illustrating a specially constructed aerial designed to eliminate oscillations of undesired frequencies

at its own frequency, causing a powerful interference. By utilizing the special antenna having loading inductances inserted as shown in figures 1 and 2, undesired frequencies have been eliminated in the manner now to be described.

It will be noted in these figures that loading inductances i of various values are inserted in the antenna at regular or irregular intervals. These coils are shunted by fixed condensers giving a plurality of oscillation circuits of different frequencies. By this means, the characteristic of the antenna is changed from a condition of substantial

It is preferable that the natural period of any of these lumped circuits be short in comparison to the wave lengths which it is desired to receive. For example, when receiving a wave of 12,000 meters, it is undesirable to use any inserted lumped circuit having a natural period greater than 5,000 meters.

While the insertion of these lumped circuits in the antenna circuit has the effect of blocking out higher frequencies, the entire antenna system must be so designed that its natural frequency will permit resonance at the wave length it is desired to receive.

The Design of 60-Cycle Transformers for Amateur Transmitters

By John J. Holahan

THE fundamental equation of the transformer is

$$E = 4.44 \times \phi \times n \times f \times 10^{-8}$$

Where, E = voltage

ϕ = maximum flux threading the coil at no load and equals the density in lines of force per square inch, B, multiplied by the area of the core A.

n = number of turns in the winding

f = frequency of applied E.M.F.

For the primary E.M.F.

$$E = 4.44 \times \phi_1 \times N_1 \times f \times 10^{-8}$$

For the secondary E.M.F.

$$E_2 = 4.44 \times \phi_2 \times N_2 \times f \times 10^{-8}$$

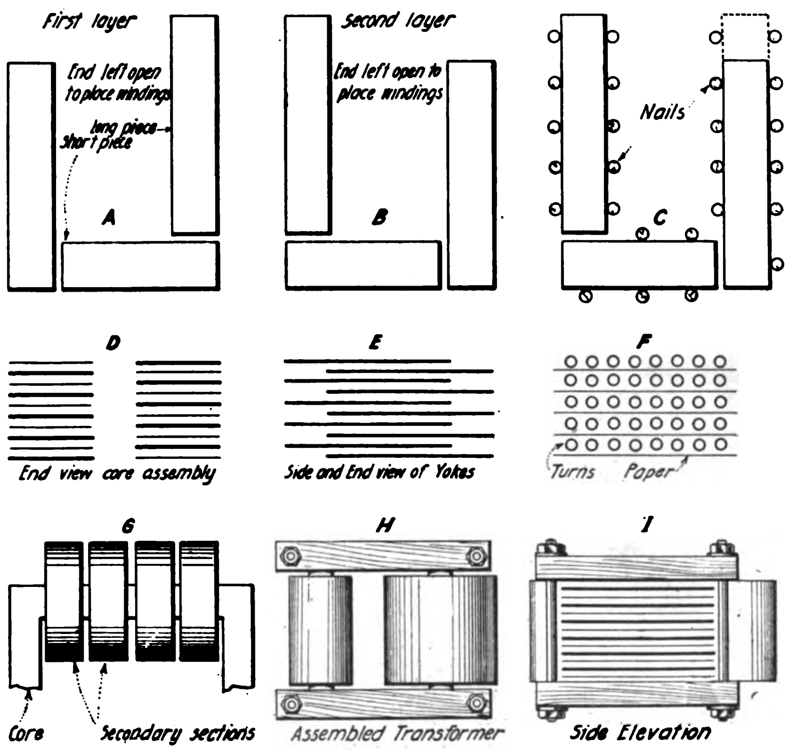
The ratio of primary E.M.F. to the secondary E.M.F. is,

$$\frac{E_2}{E_1} = \frac{4.44\, \phi_2\, N_2\, f\, 10^{-8}}{4.44\, \phi_1\, N_1\, f\, 10^{-8}} = \frac{\phi_2\, N_2}{\phi_1\, N_1}$$

If $\phi_2 = \phi_1$, that is, if there is no magnetic leakage so that all of the flux produced by the primary cuts the secondary, this becomes,

$$\frac{E_2}{E_1} = \frac{N_2}{N_1}$$

This is the ratio of the secondary E.M.F. to the primary E.M.F. and is equal to the ratio of the number of turns on the two coils. The relation does not hold for open core transformers as they have a large magnetic leakage.



Detailed design of the 60 cycle transformer for amateur transmitters

No Load Losses

The losses at no load are practically those due to hysteresis and eddy currents in the iron core.

The hysteresis loss is $W = K B^{1.6} f \overline{W}$

The eddy current loss is $W = K_2 B^2 f^2 t^2 \overline{W}$

Where, K = hysteresis constant[2] and varies with the grade of iron.

$= .0027 \times 10^{-7}$ for alloyed iron

$= .0615 \times 10^{-7}$ for ordinary iron

K_2 = a constant inversely proportional to the electrical resistance of the iron

$= 2.29 \times 10^{-11}$ for ordinary iron

$= .792 \times 10^{-11}$ for alloyed iron

B = maximum flux density in iron in lines per square inch

f = frequency cycles per second

t = thickness of laminations in inches

$\overline{W}$ = weight of iron in pounds

Iron .014" thick is suitable for transformers. At 60 cycles alloyed iron is preferable to ordinary iron.

Losses Under Load

The losses when the secondary is connected to a load are those due to the resistance of the current in the primary winding, which equals $I_1^2 R_1$

Where, I_1 = current

R_1 = resistance of the primary winding

The resistance and current in the secondary winding is equal to $I_2^2 R_2$, where I_2 = current and R_2 = resistance of the secondary winding. Added to this are the iron losses.

The I^2R losses are known as the copper losses and vary with the load. The iron losses are practically constant at all loads. The total losses are simply the addition of the foregoing losses, viz.:

Iron loss $+ I_1^2 R_1 + I_2^2 R_2$

Efficiency of Transformation

The efficiency

$$= \frac{\text{output}}{\text{input}} \text{ or}$$

output $\div$ (input + iron losses $+ I_1^2 R_1 + I_2^2 R_2$)

The efficiency of a transformer is maximum when the iron losses equal the copper losses.

A study of the fundamental formula shows that the number of turns of wire does not depend on the kw. rating of the transformer nor on the current the transformer will draw, but depends solely on the E.M.F., flux and frequency. The only effect the load rating has is to fix the size of wire. The size of wire should be from 1,000 to 2,500 cir. mils per ampere for ½ kw. and about 500 cir. mils per ampere in 10 kw. sizes or larger. To illustrate the point let us change

$$E = 4.44\, A\, B\, n\, f\, 10^{-8} \text{ to}$$

$$An = \frac{E \times 10^8}{4.44\, B\, f}$$

Substituting $E = 110$, $B = 60{,}000$, $f = 60$, we have

$$An = \frac{110 \times 10^8}{4.44 \times 60{,}000 \times 60} = 688$$

Now if $A = 1$, n should equal 688

(*Continued on page 22*)

Personalities

Lieut. Walter W. Massie, an old-timer in wireless, who commanded the crew of radio installers of Newport shown in the photo below

W. W. MacFarlane of Philadelphia with his radiophone that establishes fifty-yard communication by stovepipe aerial

Quite a number of ex-amateurs are to be seen in this group, credited with the radio installations on practically all the ships attached to the Second Naval District. Top row, left to right: Johnson, Pelletier, Gallinagh, Sumption. Second row, standing: Newcomb, Whittaker, Lester, Stewart, Wood, Martin, Litchman. Third row, sitting: Bowen, Miss Cavanagh, Clayton, Miss Pfannenmeller, Mair. Bottom row: Sweet, Vaughan, Carter, Crocker, Manuel, Downie and Riccius

My Experiences in the War

Third Instalment of the Personal Narrative of a Pioneer in Aircraft Wireless Who Was Wounded and Captured in the Attempt to Stop the Hun Invasion

By Captain Gordon Adams
South Lancashire Regiment

(*Continued from the April Issue*)

AS I lay sprawled out and helpless in the farm field, I peered through the dark. All around were other wounded, and many dead. The wounded numbered about 300, and as it was impossible for our stretcher bearers to take us away, we were left where we lay. There was a man who stayed with me for some considerable time regardless of the hail of bullets and rain of shells. I have often wished that I could find out his name. He refused to leave me, and only at last consented to go when I gave him a military order to rejoin the regiment and carry on with the retirement.

The first agony of my shattered leg was frightful. Then, when the pain had subsided to a certain extent, my chief sensation was one of raging thirst. I attempted to get my water bottle, but it was attached to my belt and I was lying on top of it, and every movement caused me excruciating pain. After a long time, however, I was successful. But I was not to have my drink. The cork was jammed. I pulled and tugged without result, and then began further struggles in an attempt to draw my sword, with which I proposed to attack the refractory cork. I was finally successful; after many futile attempts I managed to extract the cork. Then—how painful is the memory—my hand slipped and I upset the water bottle, spilling the whole of its contents!

After I had been lying there among the turnips for an hour or so the German hordes started advancing upon the position we had just evacuated. I have never heard anything more impressive. Had I known then what I know now about the Hun I doubt if I should have looked at it in the same light, but at that time we thought the Germans an honorable enemy.

The night was gorgeous; no wind and the stars brilliant. After the recent din the deathly silence was all the more marked. Suddenly, far away in the distance, I heard the faint notes of a long trumpet call. This was taken up by others like an echo; nearer and nearer came the notes; they passed, receded into the distance, and finally died away. Then a moment of dead silence, followed by the distant sound of thousands of men singing in beautiful harmony some very majestic battle song. The music swelled to thrilling intensity as nearer and nearer they came; finally, with a triumphant pæan of song the advancing Germans reached their goal. The horde had swept on.

Later in the night I had fits of delirium from which I would recover to find myself chatting merrily with a neighboring turnip. Only one man came near me during the night, and he was one of our own men who was struggling into Solesmes with 13 shrapnel bullets in him. Later I met another man who had exactly 13 bullets in him; but in his case the German soldier who picked him up, thinking it unfortunate for a man to have an unlucky number of honorable wounds, added one more to the total by pushing his bayonet through his face.

About 6 o'clock the next morning the Germans continued their advance; as a preliminary measure, however, they deliberately shot all the British wounded they could find. Out of those left with me on the top of that hill only twelve were spared. My escape was a most fortunate one. The first act of the German who found me was to pull my revolver out of its holster, point it at my face and pull the trigger. Fortunately for me it was not loaded. Just at this moment I looked round and saw a Hun officer approaching me, revolver in hand, ready to finish me off. Luckily, just before he reached me, the order came from their commanding officer to continue the advance. Otherwise, I should never have escaped the brutal end arranged for my gallant comrades.

After this I remained lying where I was. Several small parties of Germans visited me. I was greatly amused at one very juvenile Hun officer who came up, and on searching my haversack discovered my field service note book. The German did not know a word of English, but he could see that this note book contained carefully written out operation orders. He beamed all over his face, imagining no doubt that the finding of such valuable information would get him promotion. I have often wondered what happened afterwards, when it was discovered that the note book was a very old one and the orders it contained were written during Irish command manœuvres three years before.

At length a German doctor arrived and I was taken on a stretcher down to a convent in Solesmes which had been converted into a hospital. They let me lay there without attention for two or three hours. Finally, two savage Boche doctors came and proceeded to set my leg without any anaesthetic. Their method was positively inhuman. One sat on my chest while the other one hauled the leg into position and put rough splints on. In the bed next to me was a French soldier who had been hit in the knee by a shell. His leg from the knee down was only attached to the remainder of the leg by a small strip of flesh. For four days he received no attention, and by that time the lower part of the leg had started to decay. The venom of the Hun medicos passed all understanding. Yet the game spirit of the Allied soldiers was unquenchable. In the room with me were men of my own regiment, Frenchmen and Germans. Suffering as they were, though, I recall how vastly delighted was everyone when a French soldier, who apparently had not shaved for some weeks, just before his departure for some other hospital, came over to my bed and kissed me warmly on both cheeks.

I spent some time at Solesmes, and just when my thigh bone was commencing to mend orders were given that I should be moved back to Valenciennes. The only vehicle available was a small two-wheeled cart. I was put into this on a stretcher but, as luck would have it, after traversing some four miles, the horse fell down and broke my leg again. On arrival in Valenciennes the splints were removed and I was left for the night. That was the worst night I have ever spent. The muscles of the leg set up violent contractive spasms, which drove the splinters of bone inside the leg into the various nerves, adjacent to them. The pain was beyond comprehension; I thought I should never survive it. But I had more to learn of German methods. The leg was not reset until I had been at Valenciennes a week!

The hospital where we were quartered had been a girls' school and owing to the shortage of German nurses the mistress of the school had been roped in and made to do the necessary nursing. No words of mine can ever express my gratitude to those good French ladies of Valenciennes. They wore themselves to shadows, working for the English and French wounded. The old lady who looked after me had nearly been killed in the Franco-Prussian war of 1870. She was then a small girl and was sitting on her father's shoulder when he was shot by the Prussians. Her hatred of Germany and everything German was positively venomous. She was the professor of Psychology and Literature at the School and we used to have great psychological discussions together.

Masses of men, trained and highly disciplined, made the Hun army a vastly impressive machine. This view of a telegraphic headquarters gives an insight into the well organized methods within their lines

There was one particularly unusual thing which came under my observation in that hospital. I had often been told that many Orientals can die simply through an effort of will, but had never believed it until I actually saw it happen at Valenciennes. A Gurkha was brought in, wounded in the calf of the leg. Fearing that the Germans might amputate it, which is contrary to their religion, he calmly stated that he was going to die. There was no earthly reason why he should, but he did. It took him 36 hours to accomplish his end.

It was the custom to move all wounded prisoners back into Germany itself as soon as—and very often before—they were fit to be moved. In due course my turn came. I was taken to the station on a stretcher in company with several others and put into a train which was to convey us to Cologne. The senior of the French ladies who had been nursing us was allowed to come into the station to see us off. As she was handing me in some sandwiches for the journey a German medical officer doctor saw her, and for no greater offence than that of giving food to a "damned Englander" he clenched his fist and knocked her down. Not content with that, he assembled a party of soldiers who fixed their bayonets and hustled her out of the station. You may imagine how our blood boiled.

Arrived at Cologne, we were taken straight to a hospital where I found the second in command of one of our infantry regiments. He had been wounded on the same day that I had been. His instructions had been to hold a position and "never to retire," consequently although only about four of his men survived he stuck to his post though very seriously wounded himself and was subsequently taken prisoner.

Revolting is a mild term to describe the food at Cologne; in quantity it was just sufficient to keep body and soul together. And the medical manhandling was in equal evidence. During the whole time I was there a Turk derived a great deal of daily pleasure in what he pretended was a massage to my leg, his object being to inflict as much pain and do as little good as possible. Everything conceivable was done to make our lives as unpleasant as possible. For one thing, we were allowed no knives or forks to eat with, a deprivation irritating to us, but possibly meaningless to the German himself, who makes as little use of these implements as he possibly can, preferring to use his fingers. Another thing that irritated me was that shaving was forbidden.

I might mention here, that just before my arrival at this hospital one of the prisoners had lost his way in the building and accidentally got into a passage which the prisoners were forbidden to use. A sentry who he there encountered did not trouble to explain to him his error, but shot him instead. No attempt was made to reconcile the language difficulties, which were considerable, in learning the hospital regulations. It apparently gave little concern to the captors that small infractions might be expected of a most cosmopolitan collection of men, including English, French, Belgians, Turks, Arabs, Senegalese, Sikhs, Gurkhas, and others.

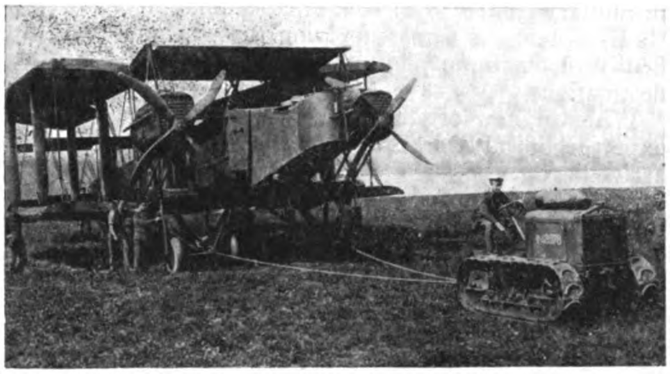
From Cologne I was taken to a prison camp at Osnabruck. Snow was falling when I arrived. Notwithstanding the cold I was put, along with four others, into a stone cellar and kept there for seven days. During that time the cold was intense but we were given fuel sufficient only to last us for three hours altogether. Our beds consisted of three planks and a sack of straw; these we had to burn in order to get a little warmth. After the week had elapsed we were put into other rooms where conditions were only slightly better. The English were always selected for the worst treatment. In order to annoy us, orders were issued that all the English were to be kept apart from each other. The sanitary conditions were filthy. We were allowed a bath but once a fortnight, and that was given grudgingly.

At length, on a certain afternoon I was told by a German *unter offizier* that I was going to be exchanged because they considered me totally incapacitated for further military service. I was taken down into the town of Osnabruck and there at a hospital I met the rest of the English prisoners who were about to be exchanged. We had dinner at this hospital and the Germans told us we could have anything we liked. There was a certain amount of grim humor in their imagining that by one hour of good treatment they could wipe out the memory of months of ill-usage. But then, in any question of psychology the German is the most perfect ass.

Clean, cheerful quarters and a staff of sympathetic attendants are the rule in American hospitals, where wounded soldiers are instructed in useful vocations, by contrast with the German idea which Capt. Adams describes

At 9 in the evening we were put on board what they were pleased to term a hospital train. It consisted merely of cattle trucks and into these were put the wrecks of humanity whom the Germans were liberating. I have

never seen such a disgraceful sight in my life as presented by those English soldiers. A large proportion were blind, and practically all the remainder were deficient of legs and arms. The whole lot were filthy and absolutely in rags. It took us 14 hours to get to Flushing and then we saw the Germans for whom we were being exchanged. They



This British official photograph shows a tractor bringing a huge Royal Air Force bomber into position, illustrating the magnitude of the problems of the author, who compiled technical data for all types of machines

all looked well fed; and they were clean and well clothed.

After a very rough crossing we landed at Folkestone and went straight up to London, where I was sent to a hospital to undergo a small operation. I shall never forget what luxury a fire and the clean sheets seemed to me.

After this I had to wait for months to get sufficiently fit for the big operation. The bone of my leg had healed up crooked, the result being a shortening of 4½ inches. The operation, which was performed in the autumn of 1915, consisted in opening the leg, sawing the bones apart, putting them into their proper places and then screwing steel plates down the side. As a testimonial to Hun savageness, for the rest of my life I shall carry about with me 16 inches of steel plating and 24 screws.

During the time I was in the hospital recovering from this operation I met another exchanged prisoner who had been shot in the arm. The Germans cut the entire arm off, leaving no stump to which could have been attached an artificial one. Shortly afterwards, when he was being moved by train from one prison to another, he asked a sentry for a glass of water. The sentry replied by sticking his bayonet through the other arm. The German doctors then removed that also, leaving in this case, as in the former, not a vestige of a stump.

It was eight months after my operation before I was fit to do even an office job; but finally, after worrying medical boards, I was taken on as head of one of the sections of the design branch in the Air Ministry. My work consisted of compiling all technical data about different types of machines and their performances when undergoing official tests. I also had to interview all inventors of new types of machines. Most of them were extraordinarily funny. One bright individual claimed that he had invented a machine which would fly for thousands and thousands of miles at a speed of 300 miles an hour without any engine power at all. He had to have an engine to get up flying speed to start with but then he claimed that further power was unnecessary, as the wind pressure would push the propeller round.

Another man had spent nine years in trying to produce a machine of the ornithopter or wing-flapping type. For experimental purposes he had rigged up in his garden a large iron frame work to which were attached the wings that flapped. The flapping power was supplied by one or more of his numerous small children who were put on in turn to wind a handle which operated the mechanism. He wished to demonstrate that by flapping the wings the whole contrivance could be made to leave the ground. It certainly did jump about 6 inches off the earth, but it did so at the moment when the wings were at the top point of each flap, when aerodynamically the machine should have been resting most firmly on the ground. The explanation was that the whole affair was jerked upwards by the inertia of upward-moving wings.

Still another budding inventor was responsible for the following bright idea: In order that fast scout machines of small gasoline carrying capacity might be enabled to remain in the air for a longer time at a stretch, he suggested that they should be followed by slow machines carrying a large supply of gasoline. When running dry, all that would be required of the pilot of the scout machine would be to fly under the large machine, and, after seizing the end of a long india-rubber pipe which the pilot of the large machine would hang overboard, deftly insert it into his own tank. Then by a manipulation of cunningly devised tap he would be enabled to replenish his tank and go on his way rejoicing. Although the inventor was suitably thanked for placing at the disposal of the Air Board his exceedingly original scheme, the idea was not acted upon as the authorities did not deem it advisable to include in the syllabus of a pilot's training instruction the art of the milkmaid.

From the Air Ministry I was appointed instructor in theory and construction at the Central Flying School. My work there was varied and interesting. On arrival I was told to reorganize the whole system of training of engine men, fitters and riggers. It entailed a tremendous amount of work, but finally I got it straightened out. My system was as follows: Each class, consisting of about 200 fitters and 200 riggers, went through the course in about 9 weeks. About the first half of this time the fitters were given instruction of a more or less general nature on each of the different types of engine which I kept in the instruction shops. The remainder of the time was devoted to specialized instruction on one particular engine. In selecting the men for their specialist course I endeavored as far as possible to allot each man to the particular type of engine which interested him most, in addition to which each man completed a short course of instruction on the simple repairs which could be done on a workshop lorry. I also endeavored to send each man for a short time to one of the flying squadrons to get practical experience of squadron work.

A remarkable picture of a group of all the American "Aces" in France, taken in France during the days of fighting, just before the armistice was signed

The training for riggers was run along similar lines, with the exception that in place of the repair work on the workshop lorries I gave them instruction in splicing and sail-making.

Each man during his course received about 400 hours instruction. I endeavored, whenever possible, by arrange-

ment with squadron commanders and the officer in charge of workshops, to give the men repairs to do which would actually be used on machines in the air. I found that it stimulated their interest considerably if they knew that some real use would be made of their work.

Apart from training mechanics I was also responsible for all the ground instruction to officer pupils. I had under me instructors in wireless, bombing, artillery observation, photography, gunnery and reconnaissance, who carried out instructions in these special departments. The theory of flight and construction of machines I dealt with myself. At one time I started to organize a wireless flight which I considered would facilitate the instruction of wireless and artillery observation. It did not last long, however, as Training Brigade H. Q. said that although this idea was excellent the necessary machines could not at that moment be spared. My perfectly good wireless flight therefore came to a sudden end.

From the Central Flying School I returned to the Air Ministry and joined the department which dealt with the design of armament, compasses and bomb sights. I had charge of designs of bomb sights and bomb carriers, and in addition I again had to interview inventors and receive their ideas and suggestions. It was to this department that the famous and historic woodpecker scheme was submitted.

In all seriousness a certain man forwarded a suggestion for training thousands of woodpeckers to fly to Germany and on arrival to get busy with their beaks and pick out the mortar from between the bricks in Krupp's gun factory so that eventually the whole building would crash to the ground.

Leaving the Air Ministry again, I took over command of and organized a new type of supply depot. This depot I found to be in a very unsatisfactory state. It was the property of one aircraft manufacturing company and was used by four others. The mechanics were entirely civilian. Its inefficiency was due to three causes: (1) lack of military control; (2) lack of co-ordination between the R. F. C. and the firms supplying the machines; (3) difficulty in obtaining pilots to take new machines to their destinations.

With the new organization I had under me a staff of expert technical R. F. C. officers and mechanics. Machines arrived from the makers in parts and were immediately turned over to the riggers for assembly. That completed to the satisfaction of the inspecting officers, they passed into the hands of the engine men, who tuned up the engine. After that they passed through various other departments for gun testing, instrument adjusting, and so on. When finally ready for flight they were handed over to the despatch officer. His duty was to know the exact position of each machine, find out in advance to what squadron it was allotted, and then have it tested and delivered at its destination. For this purpose he had under him a staff of twenty pilots. From start to finish each machine went through eleven different processes. Owing to the extremely urgent need for machines at the front all ranks had to work at least 12 hours a day.

I succeeded in a very short time in trebling the output, but I had hopelessly overworked myself and finally, after carrying on as long as possible, my leg troubled me to such an extent that I had to go on leave and was invalided out of the service on April 23, 1918.

The Design of 60-Cycle Transformers for Amateur Transmitters

(*Continued from page* 17)

and if $A = 688$, n should equal 1
if $A = 2$, n should equal 344
and if $A = 344$, n should equal 2, etc.

Any value can be chosen for A or n provided $An = 688$.

Number of Turns

The number of turns can be determined approximately as follows:

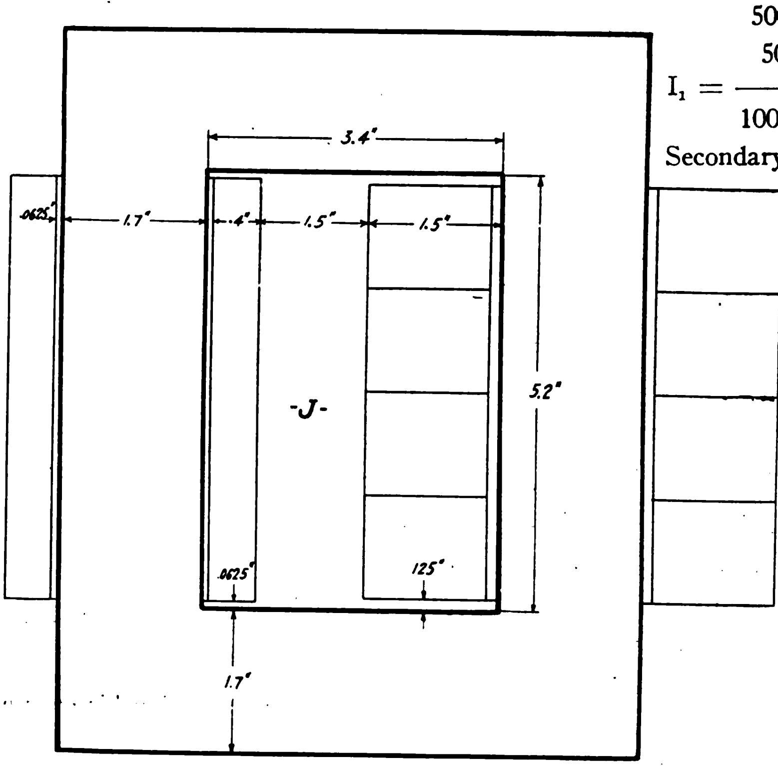
$$n_1 = \frac{E}{K\sqrt{W}}$$

Where E = coil voltage
W = watts capacity of the transformer
K = .021 for small 60 cycle transformers and K = .03 for larger transformers.

If the formula above is used to find the primary turns, the secondary turns equal

$$n_2 = \frac{E_2 n_1}{E_1}$$

In transformers for radio work, the current should be determined from the kilovolt-ampere rating rather than from the kw, rating as the power factor ($\cos \phi$) is rather low.



General plan with dimensions of the core, primary and secondary coils

Example

Let W = 500 watts
$E_1 = 110$ volts (primary)
$f = 60$ cycles
$E_2 = 13{,}500$ volts (secondary)
Power factor = .8 (assumed) = $\cos \phi$

The power $W = E_1 I_1 \cos \phi$. Substituting the above values,

$$500 = 110 \times I_1 \times .8$$

$$I_1 = \frac{500}{100 \times .8} = 5 \text{ amperes (approx.)}$$

Secondary current

$$I_2 = \frac{E_1 I_1}{E_2} = \frac{110 \times 5}{13{,}500} =$$

.04 ampere approx.

The area of the primary wire, allowing 1000 cir. mils per ampere $= 5 \times 1000 = 5000$ cir. mils. From a wire table we find that the wire nearest to this is No. 13 DCC wire. Its resistance is 2 ohms per 1000 feet. For the secondary, the area $= .04 \times 2500 = 100$ cir. mils and from

(*Continued on page* 26)

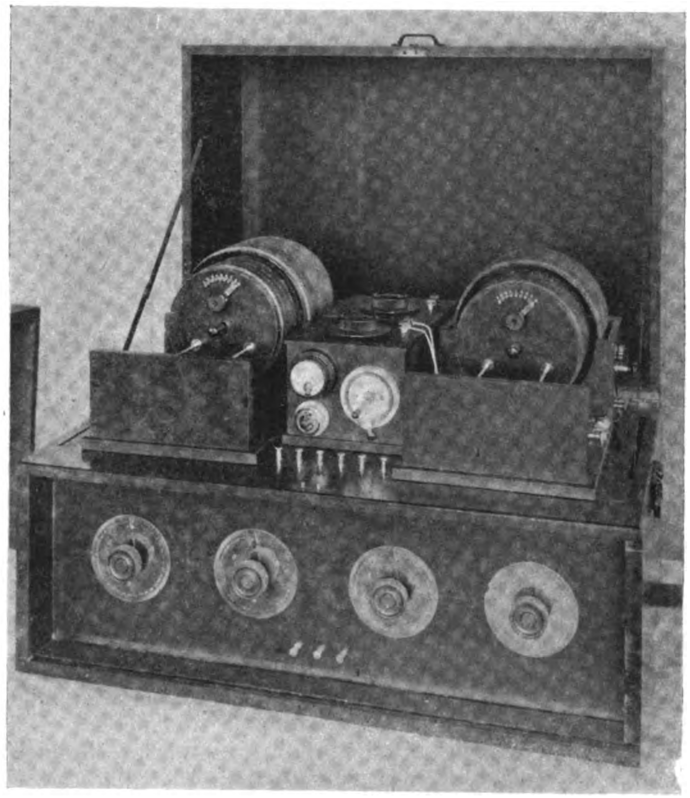
Simultaneous Sending and Receiving

A Wireless System for Duplex Operation and the Prevention of Interference

The paper read by E. F. W. Alexanderson at the April meeting of the Institute of Radio Engineers

An Abstract by E. E. Bucher,
Director of Instruction, Marconi Institute

OUTLINING an extensive series of experiments conducted mainly at the Marconi Company's high power station at New Brunswick, N. J., Mr. Alexanderson interestingly described three recent lines of radio development. Explaining how, with a duplex system for radio telephony, a land line telephone subscriber at any point in the city may pick up a local telephone and speak by radio through the wireless telephone transmitting station and receive a reply as in every-day wire telephony, the speaker gave details of what he terms the "bridge receiver" and the "barrage receiver."



Radio receiving set with barrage attachment invented by E. F. W. Alexanderson

The bridge receiver is a device which permits reception of signals at a given station while the local transmitter is in operation, with little or no interference. In this system, separate transmitting and receiving antennae are used, but they are erected close enough so that the receiver and transmitter may be considered to be in paired branches of a Wheatstone bridge.

The barrage receiver is a combination of two aperiodic horizontal antennae, which are said to have distinctly unilateral directional characteristics. By means of appropriate phase shifting devices, signals from any given direction can be balanced out while the desired signal is retained.

Regarding the system of duplex radio telephony, Mr. Alexanderson made public the diagram in figure 1, in which the left hand part of the drawing shows a radio frequency alternator N in series with the antenna system shunted by the well-known magnetic amplifier M for control of its output. The right hand part of the drawing shows a receiving antenna which is separated from the sending antenna at a satisfactory distance so that the selectivity of ordinary receivers and transmitters can be depended upon for differentiation between the wave lengths of the sending and receiving stations. Each pair of sending and receiving stations is connected together by a wire line and to the exchange of a local telephone system, so that the land line telephone subscriber may be connected to the radio station.

In the diagram, the lines from the sending and receiving stations are introduced in series with the subscriber's line. These circuits involve certain novelties of operation which the speaker explained. For example, a telephone current originating in the wireless receiving station from a distant transmitter sets up currents flowing between the telephone subscriber's instrument and the radio transmitting station. The telephone current originating from the subscriber's instrument takes the same path. This brings about the interesting condition that the currents originating in the receiving station will be re-transmitted by the sending station. As a consequence, both sides of the conversation are transmitted by each sending station and a third party may hear both speakers by tuning in on either of the two transmitted wave lengths.

In order to prevent self-exciting oscillations which may result from amplification of the local receiver currents by the proximity of the transmitter, it is necessary that the amplification of the receiver be held within a certain critical value; for if telephone currents are set up in the subscriber's line of greater intensities than the currents originally produced by the speaker, the same current will be relayed again through the sending station and come back to the speaker in an intensified form, and would be again transmitted from the first sending station. The resulting cumulative effect would be similar to that obtained in ordinary wire telephony when the receiver is held close to the transmitter.

Simultaneous Transmission and Reception with the Antennae Suspended from the Same Mast

Mr. Alexanderson showed a system for duplex radio telephony whereby two antennae were supported from the same mast, interference between them being prevented by inductive and capacitive neutralization. A diagrammatic representation is shown in figure 2, in which A is a radio frequency alternator shunted by the magnetic amplifier M, and T-1 is the microphone transmitter connected in the control circuit of the magnetic amplifier. Antenna A is the transmitting aerial and antenna B is used to create a potential of opposite phase to the potential of the sending antenna. This negative potential is transferred to the receiving antenna through the transformer T and through what is termed an exposure condenser E. The magnitude of this negative potential is adjusted to counterbalance the direct exposure between the antenna A and B, thus leaving the receiving apparatus with the coupling L at ground

potential. Since the phase relation of the transformer is not exactly 180° a residual potential is left in the receiving apparatus which may be effectively blocked out by the trap

In figure 3, the receiving antenna A-2 is connected to the primary loading coil T-2 through the counterpoise condenser C-3. The loading coil is coupled aperiodically to

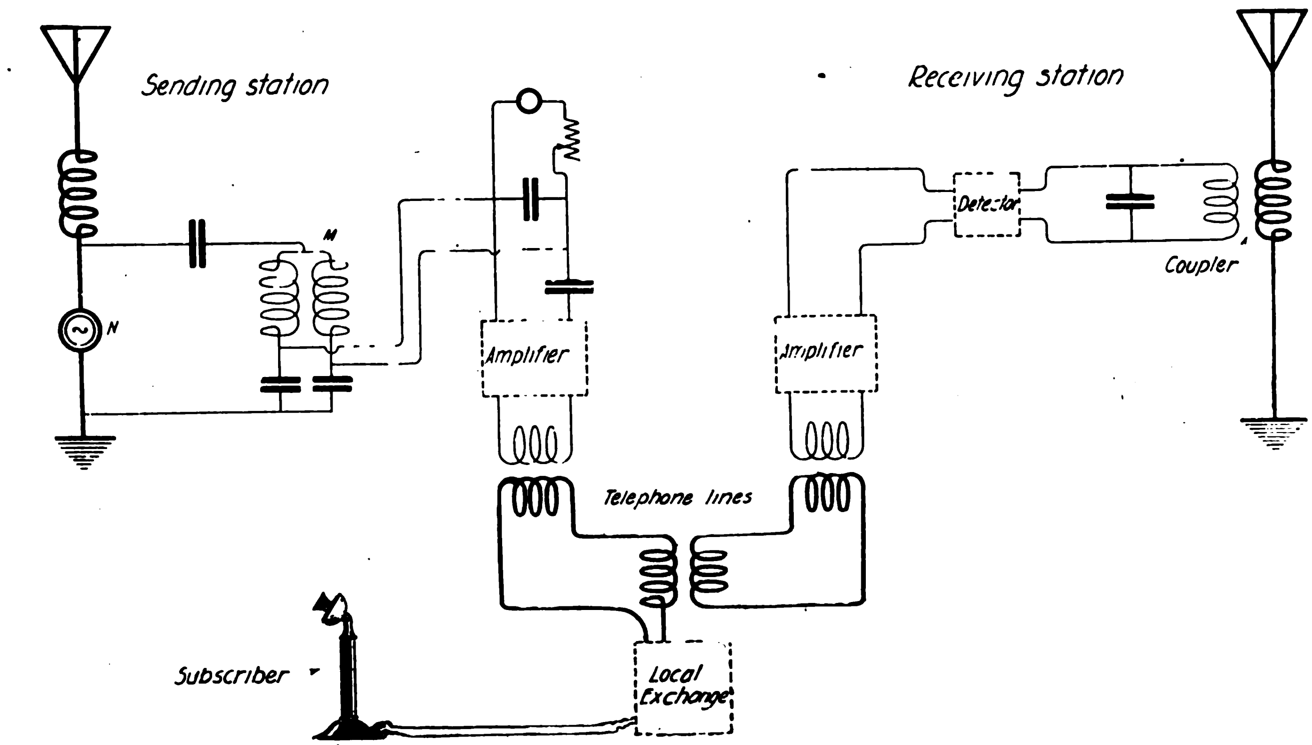


Figure 1—Radio telephone system permitting communication with land-line exchange

F, comprising an inductance and a capacity in shunt. This gives a very high impedance to the interfering current but allows the incoming signal to pass.

Mr. Alexanderson mentioned certain tests made at Schenectady, when it was possible to receive signals from stations 2,500 miles distant without appreciable interference from a sender giving 20 amperes at 10,000 volts in the antenna A.

He described the system of capacitive neutralization between the transmitting and receiving antenna as shown in figure 3; since this circuit has many of the characteristics of the Wheatstone bridge (as shown diagrammatically in figure 4) it has been termed the "bridge receiver."

the secondary of the receiving set through a linking circuit. The counterpoise condenser is connected through the exposure condensers C-1 and C-2 to the transmitting antenna. Although this method of neutralization, in large measure, eliminates the interference of the local transmitter, local induction other than that due to the capacity coupling between the antennae gave a residual effect that was eventually taken care of by a device called a phase rotor. The phase rotor feeds currents from the transmitter to the receiver at any desired phase angle; in one branch it consists of an inductance and capacity in series; and in the second branch of an inductance, capacity and resistance in series. By adjusting the position of the rotor L the electromotive

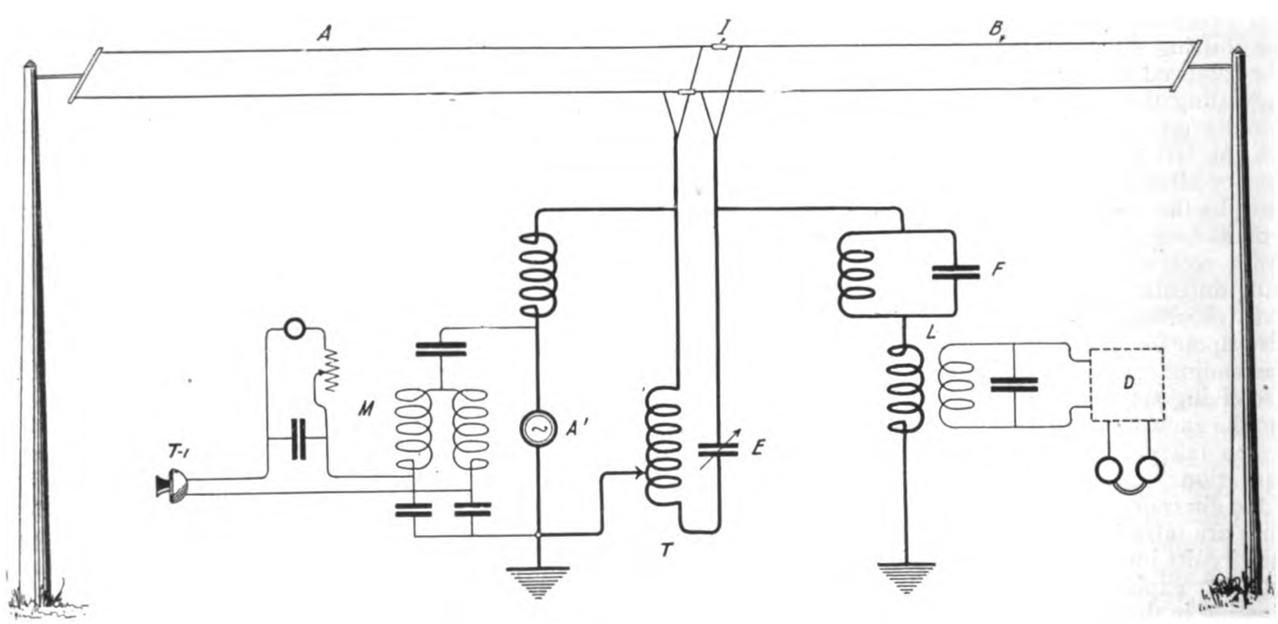


Figure 2—Radio telephone system for simultaneous transmission and reception

force induced in it may be made to assume any desired phase relation to the primary voltage. In other words, the rotor of figure 3 is adjusted to withdraw energy from the antenna circuit of the transmitter, through the coil F-1 and the transformer I, of the proper phase angle to neutralize the local action of the transmitting apparatus upon the secondary circuits of the receiver R.

In the equivalent circuit shown in figure 4, the exposure condensers and counterpoise condensers form an artificial circuit duplicating the potential drops between the sending antenna, the receiving antenna and ground. By adjusting the exposure condenser, two equipotential points are found between which the receiving set is connected. The right hand arm of the branch is effectively represented by the dotted lines, the receiving antenna in this diagram having been assumed to be one of the umbrella type.

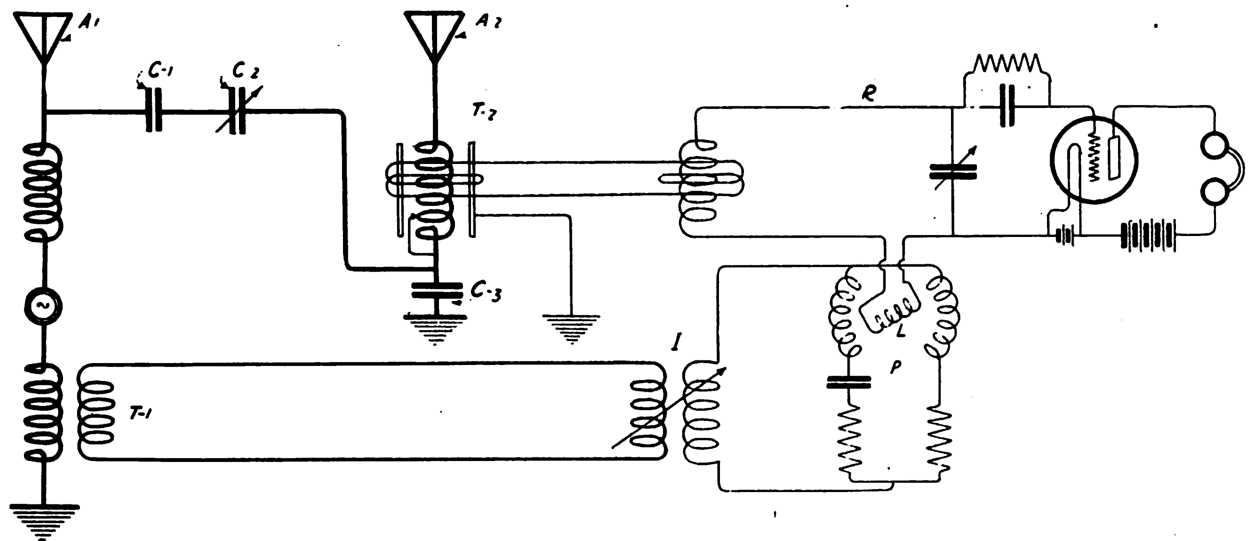


Figure 3—Fundamental circuits of the "Bridge Receiver"

Construction and Operation of the Barrage Receiver Described

The so-called barrage receiver is shown in figure 5. It comprises two horizontal aperiodic antennae which Alexanderson declares should preferably have one-quarter wave length separation for the particular signals being received. In designing the barrage receiver he observed the following principles: In his estimation, the difficulty of balancing two tuned circuits is very great and accordingly the antenna or energy collectors should be aperiodic. Second, the balancing should consist in neutralizing the electromotive forces before they have a chance to create oscillating currents. Third, the two antennae should be of the same characteristic; in other words, it is preferable to balance a magnetic exposure against another magnetic exposure rather than against an electrostatic exposure, as is done in the Bellini-Tosi uni-directional receiver.

This is accomplished in the diagram of figure 5 by two phase rotors which are coupled to the horizontal antenna. The rotors are coupled to a common detector circuit which in this diagram comprises a three electrode vacuum tube. By turning the rotary coil of the phase rotators, signals may be drawn from the antennae at any desired phase angle and thus interference from any direction neutralized.

Mr. Alexanderson states that with this apparatus it was possible to receive signals from San Diego at New Brunswick while the large transmitting station at New Brunswick was in operation. The receiving station in this case was erected about three miles from the New Brunswick transmitter.

Each of the antennae used for this demonstration were two miles in length.

A discussion of the paper followed, in which several previous patents bearing upon the principle of simultaneous transmission and reception were cited. Lester

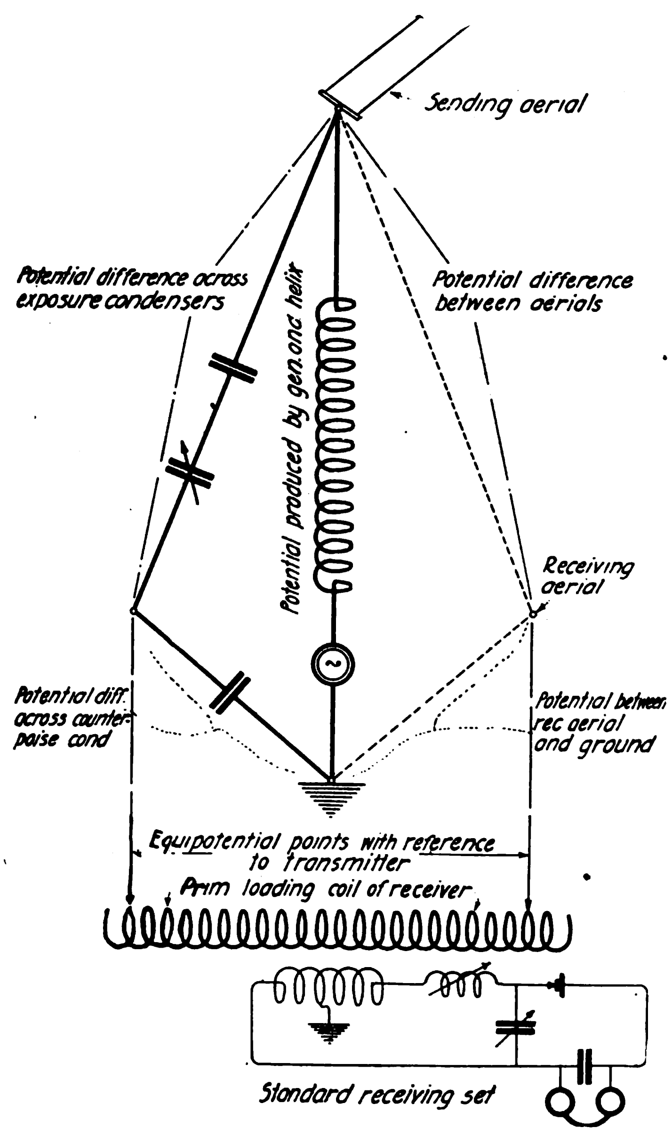


Figure 4—Equivalent circuit of the "Bridge Receiver"

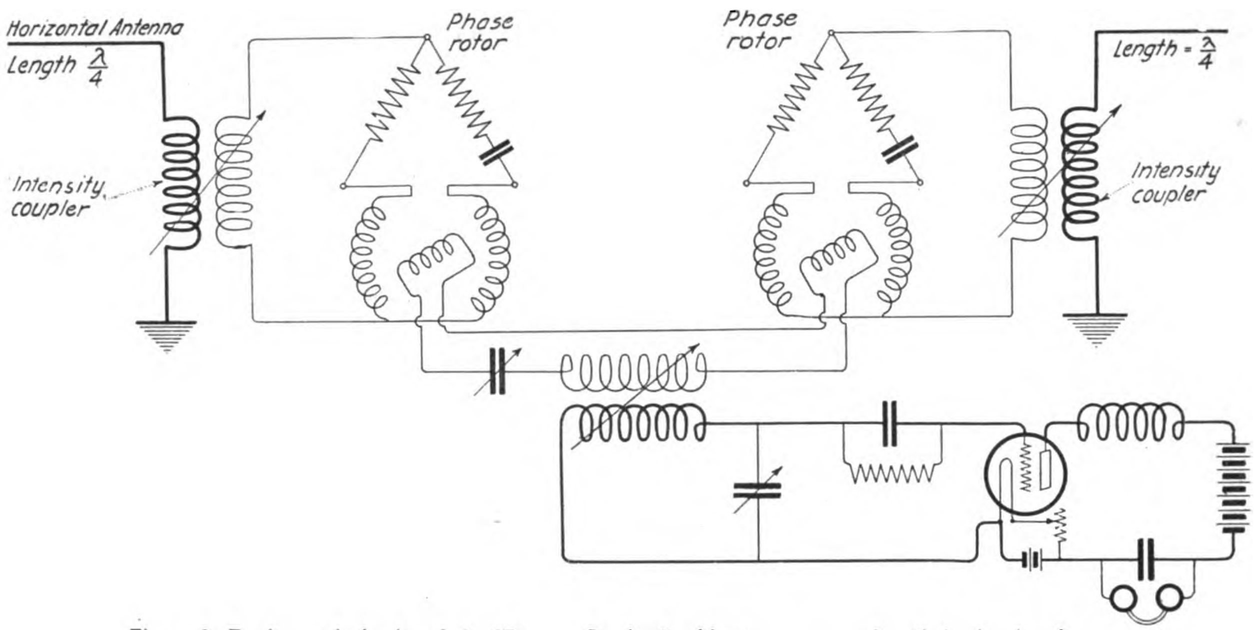


Figure 5—Fundamental circuits of the "Barrage Receiver" with phase rotators for eliminating interference

Israel and Wm. H. Priess described some experiments along that line, conducted by them at the instigation of the U. S. Government. Mr. Priess remarked that a 50 per cent difference in wave length between the transmitter and receiver was necessary to insure a factor of safety.

It was brought out that Alexanderson's duplex system with closely supported antennae, operated more effectively with undamped waves than with damped waves.

The Design of 60-Cycle Transformers for Amateur Transmitters

(*Continued from page* 22)

a wire table we find that this corresponds to No. 30SSC wire. Its resistance is about 103 ohms per thousand feet.

To obtain the number of turns on the primary

$$n = \frac{E}{.021 \sqrt{W}}$$

$$= \frac{110}{.021 \sqrt{500}} = 238 \text{ turns}$$

At 60,000 lines per square inch, A n should = 688, so that

$$A = \frac{688}{n} \text{ or } \frac{688}{238} = 2.89 \text{ sq. in.}$$

For economy of copper, the coil and core should be square in cross section; hence the core should be $\sqrt{2.89} = 1.7''$ on side.

The secondary turns

$$n_2 = \frac{E_2 \times n_1}{E_1} = \frac{13{,}500 \times 238}{110} = 29{,}274 \text{ turns}$$

DETERMINING THE PRIMARY AND SECONDARY DIMENSIONS

The voltage per section of the secondary should not exceed 4000 volts. Dividing 13,500 by 4 gives 3375 volts per coil, and dividing 29,274 by 4 gives 7319 turns per coil of the secondary. If we make each coil of the secondary square in cross section, we have $\sqrt{7319}$ or approximately 85 turns on a side. Allowing for pieces of insulation .05" thick between coils, and .125" micanite between the ends of the coils and the core, gives, allowing 4 mils insulation, 4 (85 × .014") + (3 × .05) + (2 × .125) = 5.2" as the height of the transformer window. (See figure J). Since the diameter of No. 30 D.S.C. wire is .014", the thickness of the secondary coil = (85 × .014") + 0.125 + one layer of tape = 1.5". The factor 0.125 is the thickness of the micanite tube.

Allowing .0625" as the thickness of the micanite tube between the primary coil and core, gives about 5" winding space. Dividing 5 by .078" gives about 64 turns per layer for primary coil. Dividing 64 into 238 gives 3 layers for the primary and calls for 46 additional turns to give the full 238 turns. The thickness of the primary coil is then 4 × .078 + .0625 or 0.4" approximately.

Mean length of secondary turn = 4 (1.7 + 1.4) = 12.5". And

$$\frac{12.5'' \times 29{,}274}{12} = 30{,}494 \text{ ft. total length of secondary wire.}$$

At 103 ohms per thousand, the resistance of the secondary = 30.5 × 103 = 3141 ohms. The copper loss of secondary = $I_2^2 \times R_2$ = 3141 × .04 × .04 = 6.7 or 7 watts.

The mean length of primary turn = 4 (1.7 + .4) = 8.4". This multiplied by 238 = 1999" and divided by 12 gives 166 feet as the length of the primary wire. The total resistance at 2 ohms per thousand = .166 × 2 = .332 ohms. The primary copper loss = I_1^2 R = .332 × 5 × 5 = 8.36 watts. Total copper loss = 8.36 + 7 = 15.36 watts.

The iron loss of good silicon steel is approximately .8 watt per pound. For the highest efficiency, the iron loss must equal the copper loss. Dividing 15.36 by .8 gives 19.2 pounds as the weight of iron in the core. Dividing 19.2 by .278 gives 69.4 as the total volume of the core. The length of the core with corners equals (5.2 + 1.7 + 1.7) = 8.6 inches and for two cores = 2 × 8.6 = 17.2 inches. The total volume of the cores therefore equals 1.7 × 1.7 × 17.2 = 49.7 cubic inches. Subtracting this from the total volume, 69.4 — 49.7 = 19.73 as the volume of the yokes. Dividing this by 2.89 gives 6.8 as the length of both yokes. Dividing this by 2 gives 3.4 inches as the width of the transformer window.

(*Continued on page* 38)

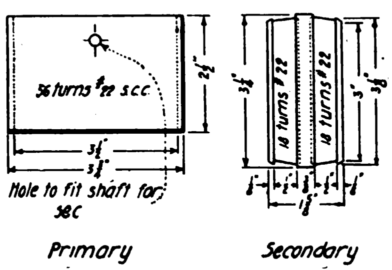
EXPERIMENTERS' WORLD

Views of readers on subjects and specific problems they would like to have discussed in this department will be appreciated by the Editor

My Conception of the Ideal 200 Meter Receiving Set

By Frank V. Bremer

A RECEIVING tuner for amateur wave lengths should have a range of tuning between 180 and 580 meters, and should be fitted with a regenerative coupling. With the set described here, amateur stations as far west as Denver have been copied in New York, a distance of approximately 1900 miles.



Figures 1 and 2—Dimensions of the primary and secondary coils of the receiving tuner

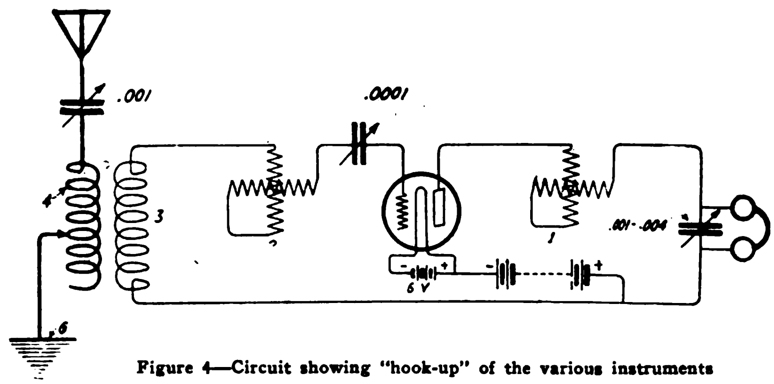


Figure 4—Circuit showing "hook-up" of the various instruments

Aerial

The amateur aerial should consist of from 4 to 8 stranded wires with a horizontal length of from 80 to 100 feet and a vertical height of from 30 to 100 feet, with an approved type of modern lead-in insulator. All connections must be securely soldered.

Earth Plate

A good earth plate can be formed by burying square sheets of copper or brass about three feet below the surface under the whole length of the aerial. In addition, the ground lead should be connected to all gas and water pipes available in the building.

with 56 turns of No. 22 SCC wire with a tap taken from it every eight turns. These should be brought out to a switch. The dimensions are shown in figure 1.

The secondary should consist of a ball turned to the shape of a variometer, 3¾ inches long by 1⅝ inches in diameter, wound with 18 turns of No. 22 SCC wire on each side, or 36 turns in all. Both coils are wound in the same direction and no taps are to be taken off. The inductance is varied by turning the rotating coil. The dimensions are shown in figure 2.

Variometers

The variometers are turned from wood and should consist of two field frames and one rotor, sizes as per the drawing, figure 3. Two are required, both of the same size.

The field frames of the variometer for the grid circuit are wound with 30 turns of No. 20 SCC wire, wound clockwise; the rotor is wound with 32 turns No. 20 SCC wire, wound counter clockwise.

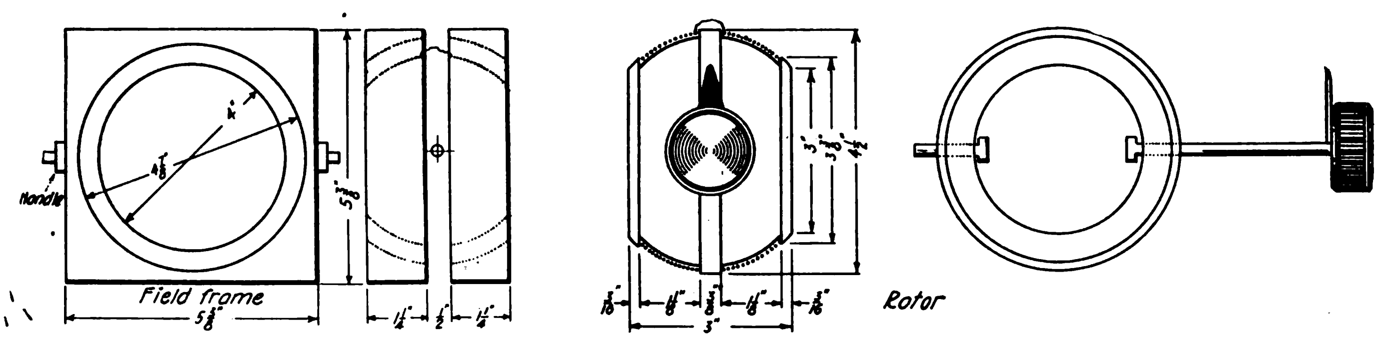


Figure 3—Dimensions of field frames and rotor for the variometer

Receiving Tuner

Special care should be taken in the construction of the tuning transformer. The regenerative valve short wave receiver, consisting of two variometers and a coupler which can be mounted together, or separately, constitutes in my mind the most efficient set.

The primary should consist of a cardboard or bakelite tube 2½ inches in length by 3¾ inches in diameter, wound

The field frames of the variometer for the plate circuit are wound with 25 turns of No. 18 SCC wire, wound clockwise; the rotor has 27 turns of No. 18 SCC wire, wound counter clockwise. The dimensions of the rotors are given in figure 5.

The design of the variometers should be such that they may be rotated throughout 180°. Coil 3 in figure 4 must rotate through 90°. Coil 4, the primary, is stationary.

The field frames are stationary and must be separated ½ inch. The horizontal axes of the variometers must be at least 12 inches apart.

Telephones

For the best results a pair of Baldwin amplifying telephones should be used, but any pair of 2,000 ohm telephones will prove satisfactory.

Detector

It is essential that a good three element valve detector of either the round or tubular type should be used and special attention paid to the voltage adjustments. A storage cell should be used for lighting the filament, as it is important that the current be constant. For the plate circuit, flashlight batteries or a bank of small storage cells may be used. For maximum signals, a single cell adjustment of the plate battery should be provided for.

Variable Condensers

Three variable condensers of the following capacities are required, viz.: one of .001 mfd. for variation of the primary wave length, one of .0001 mfd. for the grid circuit; and one of .001 to .004 mfd. for shunting the telephones.

If these instructions are carefully carried out, a set capable of amplifying 100 times will result. All connections should be thoroughly soldered and the dimensions of the coils and the capacities of the condensers duplicated in detail.

For those who prefer the cabinet type of apparatus, a suggested design is shown in figure 5.

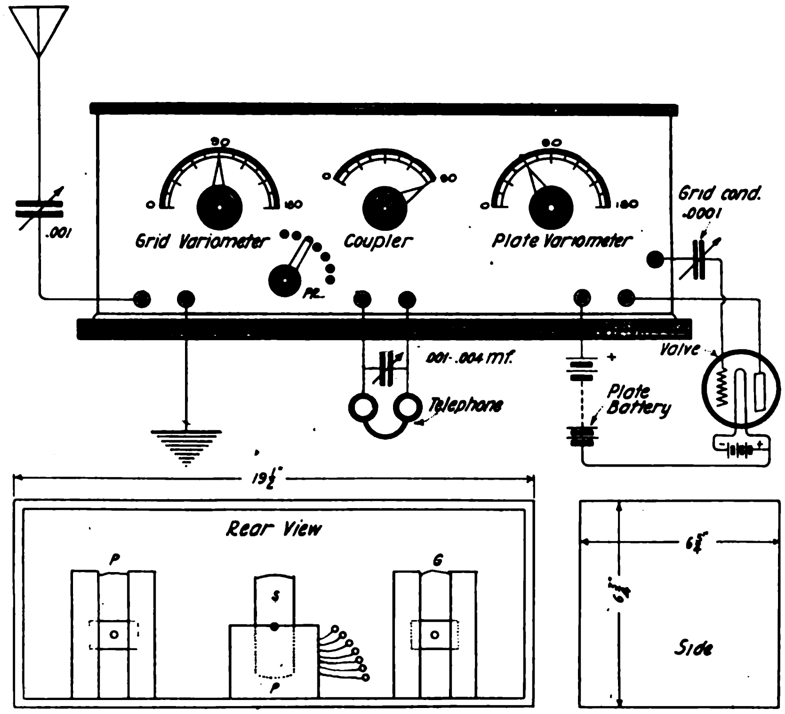


Figure 5—Design of a cabinet set

Useful Experimental Apparatus for the Amateur's Laboratory

By Thos. W. Benson

How to Design a Water Rheostat

It is seldom that the experimenter gives a second thought to the proper design of a water rheostat. The usual method is to use as large plates as possible and add salt or acid to the solution until sufficient current flows. Often the water heats badly and boils, resulting in a constantly changing resistance. To the many experimenters who use this convenient and cheap form of resistance the following suggestions are offered to assist them in building a rheostat suitable for the work in hand.

The problem of designing a rheostat is usually a question of the size and kind of plates, the density of the solution and the chemicals at hand. The following method will give accurate results within the range of the usual amateur's requirements.

The maximum current that can be handled by a water rheostat depends chiefly, among other things, on the cubic inches of electrolyte in the container. It would appear that the energy absorbed would be limited by the radiation surface, but calculations on this basis do not agree well with experimental results.

Suppose we have a large porcelain battery jar and wish to construct a rheostat to use with an arc lamp. First determine the cubical contents of the container in the usual manner. The jar used by the writer in an experiment of this kind measured 7 inches inside diameter and 12 inches high. Allowing one inch at the top gives a solution height of 11 inches, or a trifle over 422 cubic inches of solution. When used indoors without special cooling, the rheostat is limited to 2 watts per cubic inch, hence the rating of the rheostat would be 2x422 or 844 watts.

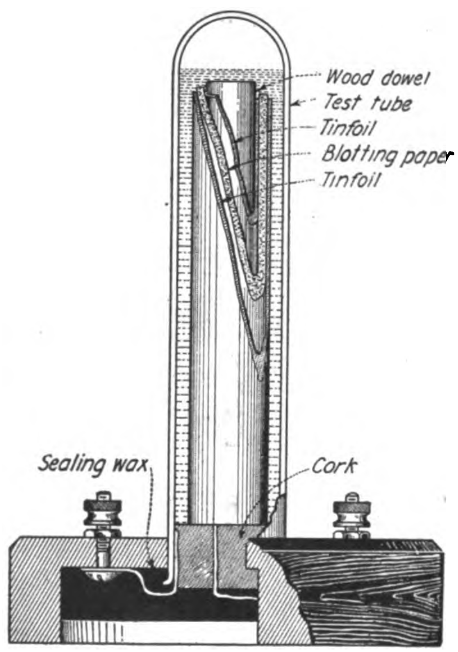


Figure 1—Showing construction of an experimental type of the photo-electric cell

We must decide on the maximum voltage drop desired. Since the rheostat in question was to operate with an arc lamp, 80 volts drop was decided upon, allowing 30 volts minimum across the arc. Dividing the wattage (844) by the voltage drop (80) we find that the current in amperes will be 10.55 or roughly 10 amperes.

The allowable maximum current density for the plates is one ampere per square inch. However, there is plenty of room for the plates, which were cut from 1/16 inch iron, 5 inches in diameter, giving an area of 19.6 square inches. The upper plate was perforated with holes by means of a twenty penny nail and fastened to the adjusting rod by two bolts, one on either side of the plate. The lower plate was left plain, a rubber covered wire being used to make connection to it.

Now that we have finished the mechanical design of the rheostat, we will determine the proper density of the solution. The chemical is a matter of judgment. We have the choice of sodium sulphate, sodium chloride or copper sulphate with iron plates. Where lead or carbon plates are used sulphuric acid may be employed.

The formula for calculating the density of the solution in per cent is as follows:

$$\% = \frac{DK}{V}$$

Where, D = the maximum distance between plates
V = maximum voltage drop
K = constant obtained from table following

Sulphuric acid—.08
Sodium Chloride—.25
Sodium Sulphate—.45
Copper Sulphate—.90

For the rheostat under consideration copper sulphate was selected because it does not gas or polarize the electrodes. The density from the preceding formula is:

$$\frac{10 \times .9}{80} = \frac{.9}{8} = .1125, \text{ or a little over } 11\% \text{ by weight.}$$

This was found to give the desired result and worked perfectly with the arc without heating to a noticeable extent. A water rheostat for any experimenter's requirements can be designed from these data by bearing in mind the relations the various factors bear to each other. These may be listed as follows:

Energy absorbed depends on cubic inches of electrolyte.

Area of plates depends on current. One ampere per square inch is not to be exceeded.

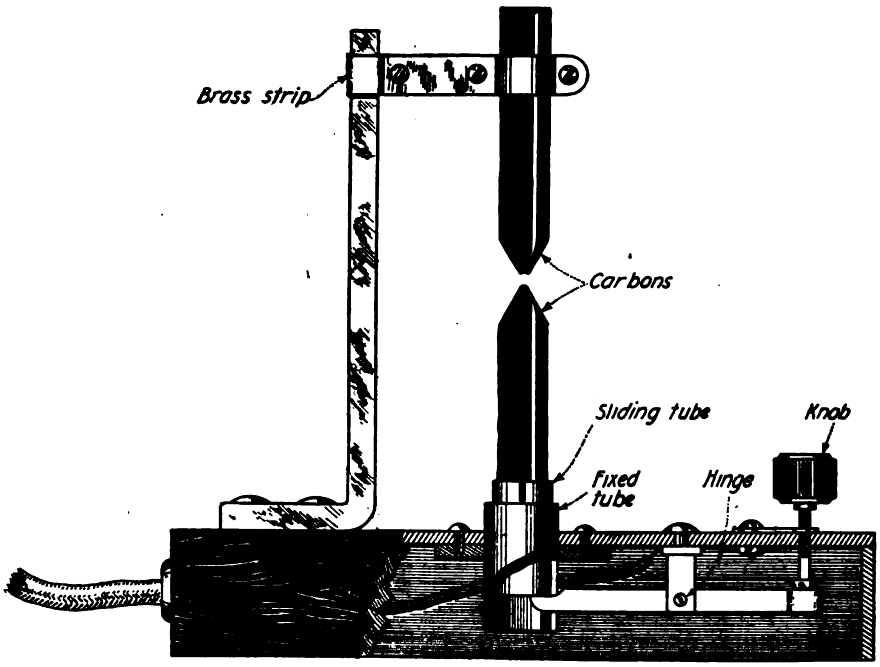


Figure 2—Showing the design of the hand-fed arc light

Voltage drop depends on maximum distance between plates. When this is determined by size of container the density of solution is varied to obtain the proper result.

Experimental Photo-Electric Cells

Photo-electric phenomena offer such a fascinating field of study that it is strange more experimenters have not turned their attention to the subject. It is a simple matter to construct the various cells that have been developed in the past, while the study has many possibilities.

The simplest form of photo-electric cell consists of two sheets of tin foil in a solution of salt water. One of the sheets is exposed to light while the other is kept in darkness. A modified form of this cell devised by Fleming can be constructed as shown in figure 1. A sheet of heavy tin foil measuring 4 inches square is wrapped around a wooden dowel ½ inch in diameter. A sheet of thin blotting paper is wrapped over the tin foil and a second tin foil wrapping applied. The whole can be held together with small rubber bands. A tiny wooden dowel serves to fasten the elements of the cell to the cork of the test tube. Tin foil leads are brought out through slits in the cork. The whole is placed in a test tube filled with water to which a little salt has been added.

With this form of construction, the inner tin foil plate is protected at all times from the light. When the cell is connected to a sensitive galvanometer a slight current will be detected, even with the cell in the dark. This is due to the fact that a current is generated when two electrodes are put in a solution, regardless how similar they may be in their physical appearance.

When a strong light falls on the cell a marked increase of current will be noted flowing from the shaded cylinder to the lighted one, in the exterior circuit.

In experiments with photo-electric cells some form of artificial light is preferred to sunlight. The light from burning magnesium ribbon is very satisfactory, but where lighting current is available an arc light is the better of the two.

A hand-fed arc light that can be easily constructed from parts on hand is shown in figure 2. The base is a shallow cigar box; a bent rod and a holder made from strip brass holds the upper carbon. The lower carbon is fitted into a tube that slides in a larger tube attached to the base. A slot cut in the fixed tube allows free movement of the brass lever to raise and lower the carbon holder. The lever is made from a switch blade drilled at the center and pivoted on a switch hinge clip. A threaded rod with an insulating knob serves to operate the lever. A water rheostat made from an Edison battery jar, 13 by 7 inches with circular plates 5 inches in diameter, will give the necessary current regulation.

Returning to the photo-electric cells, the Fleming cell can be improved by using silver foil for the plates. Still further improvement can be obtained by coating the lighted plate with silver salts.

A cell employing chloride of silver can be made as shown in figure 3.

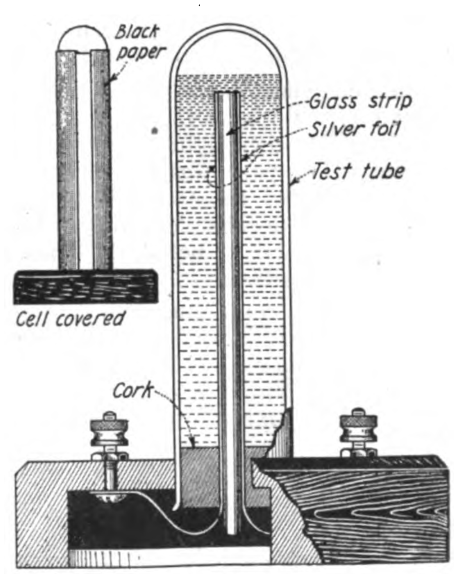


Figure 3—Photo-electric cell using chloride of silver for coating the lighted plate

Strips of silver foil are attached to a narrow strip of glass by means of melted pitch, the strips extending 1½ inches over one end. An emulsion is prepared, consisting of a little finely powdered silver chloride and collodion which are shaken together in a test

tube in the dark, or at least the tube should be covered with black paper. Pour this emulsion on one of the silver plates in a dark room and allow it to dry.

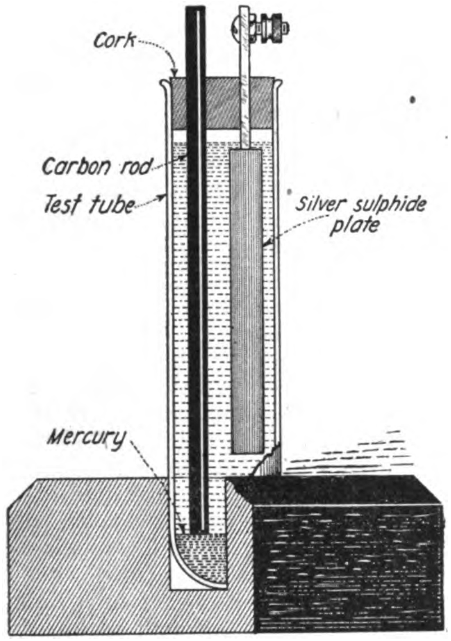


Figure 4—The Sauer photo-electric cell

The glass strip with the plates is now mounted in the test tube by cutting the cork in half and hollowing out the center so as to pass the strip tightly. The test tube is filled with distilled water to which a little table salt has been added. The cell can now be assembled and after making connections to the protruding strips of silver foil, the whole can be sealed with sealing wax as shown. The test tube is now covered with black paper with the exception of a space ½ inch wide down the side nearest the coated plate.

The cell when connected to a galvanometer will give a slight current in the dark, but when light from the arc is allowed to pass through the uncovered part of the tube on to the coated plate, a decided deflection of the galvanometer will be noted, the coated plate being positive.

If a solution containing a few drops of sulphuric acid is used in the cell the results will be the same. This indicates that the action is independent of the electrolyte, the salt or acid serving merely to reduce the resistance of the water.

This cell is fairly sensitive; dull sunlight will give a current and even a candle will cause a deflection if a sensitive galvanometer is used. It will be noted also that the current generated varies directly as the strength of the light falling on the cell.

Different colored lights will also give varying current strengths. The light from the violet end of the spectrum has the greatest effect, while the effects of red are scarcely noticeable.

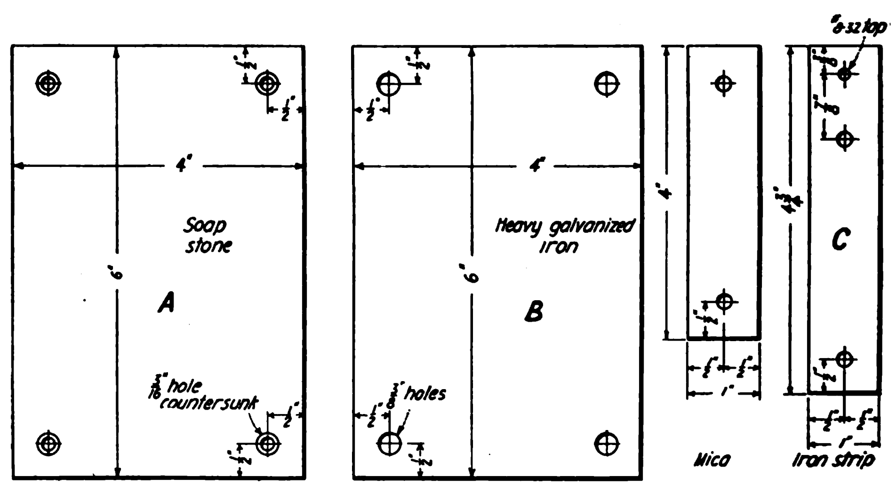


Figure 5—General plan of construction of the graphite laboratory stove

Similar effects may be observed if any of a number of other silver salts are employed for coating the plate. Thus a silver bromide emulsion may be made as explained, keeping it away from the light while preparing it. A few grains of potassium bromide is added to the water in the cell. A mixture of silver nitrate and rather thin gelatin may also be used with the results noted, barium nitrate being used in the solution.

Possibly the most sensitive cell using silver salts is that devised by Sauer. A cell of this type may be constructed as shown in figure 4. A large test tube contains at its bottom a small quantity of mercury, to which connection is made with a thin carbon rod. If preferred, a platinum wire can be sealed into the bottom of the tube to make this connection. A plate of silver sulphide is supported in the upper part of the tube and in a position to be freely acted upon by the light. The solution used in the cell consists of 100 parts water, 15 parts common salt, 7 parts copper sulphate. The cell is mounted upright in a wooden block.

This cell is very sensitive to light and gives quite an appreciable current. The rapidity with which it follows variations in light intensity would make it suitable for registering light variations, and perhaps with modifications, would make it rank a close second to the unreliable selenium cell.

The reaction taking place in this cell is rather complicated and is thought to be as follows: The copper sulphate and salt (sodium chloride) form a cupric chloride which is reduced to cuprous chloride by the mercury. The cuprous chloride acts on the silver sulphide plate in the presence of light to form silver chloride with the result that a current is generated.

Another type of cell that is rather sensitive employs copper plates. The one under the influence of light is oxidized while the other can be left plain. A strip of thin copper is oxidized by holding it in a Bunsen flame until black. Another similar strip is cleaned with sand paper. The two are then fastened to a strip of glass in a manner similar to that employed with the silver cells. The details of the mounting are the same, a few grains of copper sulphate being added to the water in the cell. The test tube is covered with black paper, excepting a space down the side nearest the oxidized strip.

This cell will give a fairly strong current in bright sunlight. By coloring the plate exposed to light with such dyes as eosin, malachite green, or napthol yellow, the effect will be increased. It will be found also that the violet end of the spectrum gives the strongest current.

In all probability the following is the true explanation of the action of all photo-electric cells: Ultra-violet light, whose waves are shorter and more rapid in vibration than the visible violet rays, has a marked reducing effect on many chemicals in solution. Oxidization or reduction at any pole in a solution will produce a current of electricity. This would then explain the action in the case of cells employing silver salts, for their reduction by light is utilized in photography. Furthermore, it has been found that some metals when immersed in a solution and exposed to strong ultra-violet light throw off tiny charged particles in what is termed a collodial condition. This cannot be done without leaving an opposite and equal charge on the plate, and the result is the passage of this charge to the other pole not so exposed. This, then, must be the action in cells employing similar plates for the electrode as the Fleming tin foil coil.

Summing up, a photo-electric current is produced in two ways. First, by the use of a cell in which the chemical action depends on the presence of light. Second, by a cell that depends upon the discharge of negatively charged particles under the influence

of light to cause a disturbance of the electrical equilibrium between the poles. The latter type is, strictly speaking, the true photo-electric cell and this form no doubt will solve the problem of utilizing the sun's energy. Further investigation of metallic colloids may add considerable to our knowledge of photo-electricity.

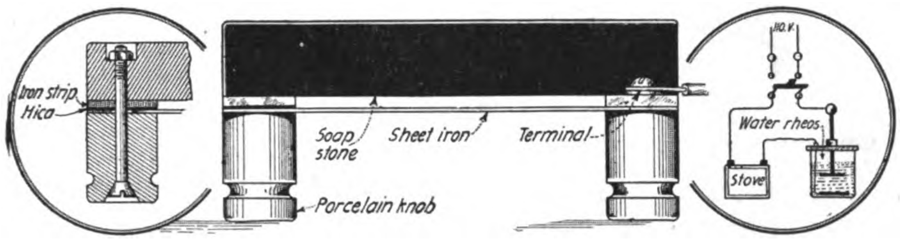


Figure 6—Graphite laboratory stove assembled

A GRAPHITE LABORATORY STOVE

Although graphite is a conductor of electricity, it differs from metals in that its resistance drops as the temperature increases. If it could be evenly distributed in sufficient quantities on a smooth surface and made to adhere with sufficient tenacity, it would be a convenient means for generating heat by electricity up to the point where graphite is burned by the oxygen of the air.

Unfortunately the rubbing of graphite alone on a surface does not give a coating heavy enough to conduct an appreciable amount of current. Although it can be applied with a brush in the form of a paste, the results are very unsatisfactory, for it flakes off easily.

This makes it necessary to use some form of binder, but because they are not able to stand the high temperatures to which graphite can be submitted without harm, the maximum temperature of the device is limited. However, very satisfactory heating units for the laboratory can be constructed in the manner hereafter described.

The mechanical details are of little importance, but the form of stove described will fill the usual requirements of the experimenter's laboratory.

From soapstone ⅞ inch thick cut a piece measuring 4 by 6 inches. This is drilled as shown in figure 5, the holes being countersunk to a depth of ⅜ inch with a ⅜th drill.

Two strips of iron ⅛ inch thick, 1 inch wide and 4¾ inches long are procured. These strips are drilled as shown at B in figure 5. A sheet of heavy galvanized iron 4 by 6 inches is cut and drilled with holes as shown at C, figure 5. Two strips of mica 4 inches long and 1 inch wide with a hole punched at each end, four 8/32 flat head iron bolts 1½ inches long, and four porcelain knobs 1 inch in diameter and 1 inch high, are required to complete the stove.

The graphite used in constructing the stove can be purchased in the form of a well known stove polish on sale in every grocery store. This is to be mixed with water and applied with a brush.

Lay the soapstone slab on a tripod or other support and arrange to heat it with a bunsen burner. Take the two iron strips and smear them thickly on one side with the stove polish; similarly treat the ends of the soap stone slab where they will be fastened. Lay them on the slab and drop bolts through the holes to keep them in position. By means of screws in the end holes of the iron strips connect them to the 110 volt supply through a lamp bank or other resistance.

Heat the stone with the bunsen burner till it is hot enough to evaporate water rapidly but without sputtering. Apply a rather thin coating of the paste with a brush to the surface of the stone, using long strokes. Cover the entire surface on each application but do not pass twice over the same place with the brush. The stove polish is known as X-Ray Stove Polish.

After each application polish the surface vigorously with a stiff toothbrush. As the process continues the graphite coating will soon become thick enough to conduct electricity, which will then serve to heat the stone. If an ammeter is handy it should be connected in the circuit and the application of graphite continued until two amperes flow in the circuit. In the absence of a meter, two 50 watt incandescent lamps can be connected in parallel and when these light to full brilliancy the coating is heavy enough.

When the stone has cooled the stove can be assembled. Remove the bolts from the corner holes without disturbing the iron strips, lay a strip of mica on each iron strip, cover the whole with the galvanized iron plate, centering the small holes in the strips with the larger holes in the plate. A bolt is then dropped through each porcelain knob and the protruding end of the bolt passed through the stove unit and fastened thereto by a nut fitting into the countersunk holes on the top surface of the soapstone slab. When all four legs are securely bolted in place the stove is complete.

Connections are made to the extending iron strips, a water rheostat being included in the circuit to control the current and hence the temperature of the stove. The temperature should not exceed 400° C. Before using, the stove should be matured by heating to 400° C. and kept there for two or three hours. Thereafter its temperature at any given current input will be fairly constant. The assembly is shown in figure 6.

SPEAKING INCANDESCENT LAMP

Those having the facilities may perform the rather novel experiment of making an incandescent lamp reproduce words spoken into a telephone transmitter.

A 500 watt, type B, mazda lamp is connected to the 110 volt direct current supply as in figure 7. Shunted across the lamp, as shown in the diagram, are the secondary of a telephone induction coil and a ½ mfd. condenser. A telephone transmitter and six dry cells are connected to the primary of this coil.

On speaking into the transmitter the lamp will reproduce the words, which can be heard when the ear is held rather close to the globe.

To explain the action we may suppose that the voice currents are added to the current flowing in the lamp circuit, causing it to burn more or less brilliantly. The resulting changes in temperature are communicated to the glass and thus to the air. It is not improbable that some similar arrangement might be used to modulate the waves emitted by the electronic relays used in short range wireless telephones.

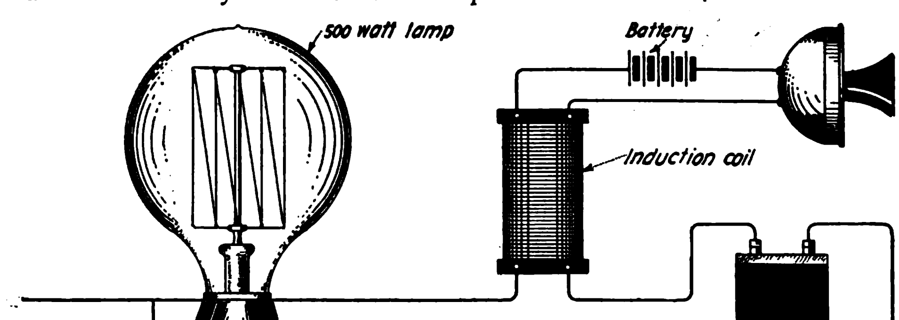


Figure 7—Diagram showing connections and installation of the speaking incandescent lamp

Hot Wire Ammeter

By C. J. Fitch

ARTICLES have appeared in the various magazines describing the construction of a hot wire ammeter for the wireless experimenter, but the main objections to these meters are the uncertainty of the zero positon on the scale, and inaccuracies due to a change of the surrounding temperature. To overcome these disadvantages I designed the meter shown in the diagram, figure 1.

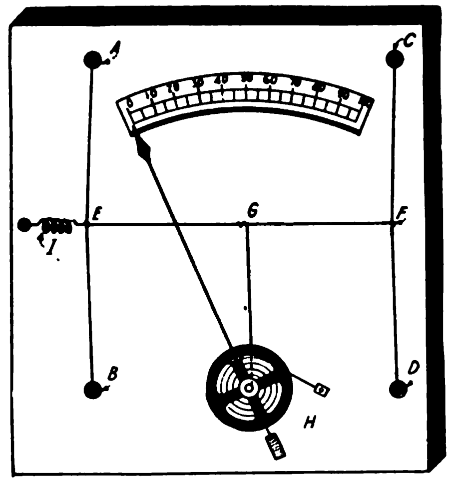


Figure 1—Design of the hot wire ammeter

Two resistance wires AB and CD, each 4 inches long by .003 inches in diameter, are clamped between binding posts, using a paper washer to prevent slipping. EF is a silk thread 4 inches long. Another thread is tied at G and wound around the shaft on which the hair spring H is mounted. The hair spring tends to move the pointer to the right, but it is held on the zero position by the silk thread. The hair spring and its bearings were taken from an old alarm clock. I is a small spring, or rubber band, which should be very strong as compared with the hair spring. The pointer is cut along the band of a folded paper to give it stiffness. It is fastened to the shaft with a bit of sealing wax, by melting it off the point of a file.

If the wire AB expands, the spring I will pull up on G and move the pointer to the left. If the wire CD expands, it will slacken up on G and the hair spring will move the pointer to the right. It is evident then, that when both wires expand or contract alike, due to a change of the surrounding temperature, the pointer will not move. The current to be measured should flow through the wire CD. The meter may then be calibrated by comparing it with a standard instrument.

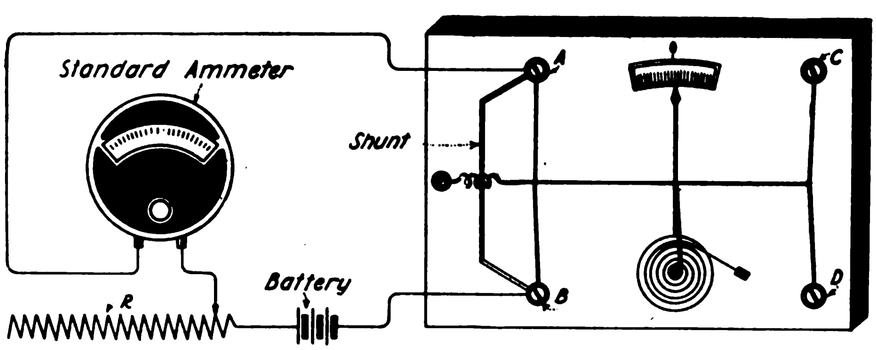


Figure 2—Showing the hot wire ammeter connected up for calibration

Those who have a larger meter at hand, or who wish to make extremely small measurements, should note the diagram, figure 2. Here the wire AB has a shunt in parallel with it, and the instrument is connected in series with an adjustable rheostat, the large meter and a battery. The scale of the meter is also changed as shown.

The current to be measured is passed through the wire CD, which moves the pointer to the right of the zero position. By adjusting the rheostat R, the value of the current flowing through the wire AB can be varied until it equals the current through CD, and the pointer will move back to zero. At this position the reading of the large meter should be taken and divided by the ratio of the shunt across AB. This result will be the value of the current through CD. For example, suppose the shunt has such a resistance as to allow 1/100 of the current to pass through AB. When .01 ampere flows through CD, to bring the pointer back to zero, .01 ampere should flow through AB, or 1 ampere through the large meter, which can be read more accurately. In this case a rheostat of 5 ohms maximum should be used, with a battery of two dry cells.

QRM Amongst Amateurs

THE articles I have read from time to time regarding wave length restrictions, interference, power input, etc., do not seem to present the solution to the problem. Nor will I pretend to offer a complete solution; but I have some suggestions which may prove of interest.

There are those who apparently believe that by requiring a speed test of from 15 to 20 words a minute, a minimum amount of interference between amateur stations would result. In my opinion, such would not be the case. I have heard the 20-words-a-minute man QRM the air to as great an extent as anyone else and, at times, there were some who seemed to think that their superior operating ability entitled them to hold the ether indefinitely.

QRM is QRM any way you may take it, and the imperative thing is to eliminate it in a systematic manner. This elimination will come in time, but only as experience suggests the remedy. I cannot see that the amateur would be any better off with a speed requirement of 15 words a minute, from a QRM standpoint. I must confess that I am not sufficiently informed to determine the best method for controlling QRM, or the amateur, but I do not believe that the solution of the trouble lies in the matter of speed.

In my opinion, the requisites for a *transmitting license* should be based upon the following:

1. Character and responsibility of the applicant.
2. Care and operation of apparatus.
3. Knowledge of the laws pertaining to the amateur.
4. Application for license to be approved by nearest recognized radio club or association, before being filed with radio inspector. No transmitting license to be granted unless this is done.

Advanced amateurs can help educate those who are striving for a license to operate their apparatus so as not to cause needless interference. I refer more particularly to the small boy and the irresponsible person.

I believe that radio clubs throughout the country, if they are permitted to do so, can solve the amateur problems better than anyone else.

As to power input and wave lengths, I make these suggestions: Let the standard wave be 250 meters. Relay work on trunk lines should be conducted at 425 meters, and certain hours alloted for trunk line work. All stations not officially designated as trunk line stations should operate on wave lengths not exceeding 250 meters. This will effectually eliminate interference with relay work, or at least reduce it to a minimum. Official relay stations when operating between each other during relay hours, except for trunk line work, should be compelled to confine their operations to a wave length not exceeding 250 meters. This is only meant as a suggestion, as conditions in some localities may warrant something different from the actual figures I have given.

The standard power input should be 1 kw. except for those stations situated within a certain distance of government stations, when it might be advisable to curtail the power.

W. T. Gravely, *Virginia*.

Donle's Variable Condenser

In the usual type of rotary variable condenser, the capacity is almost directly proportional to the movement of the rotary plate. Although this type

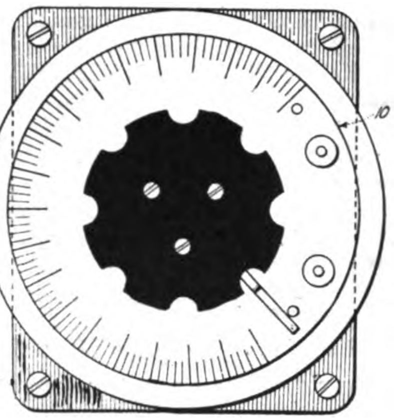


Figure 1—Top view

has proven fairly satisfactory for radio work, it possesses certain serious defects. For one thing, the percentage variation in capacity is small for it is impossible to adjust with any degree of accuracy below a certain point on the scale, say 15 degrees, and because air is the usual dielectric, a condenser of small capacity occupies considerable space. Furthermore, in the usual type, the rotating plates tend to throw the shaft out of balance so that a slight jar results in a movement which is sufficient to destroy the adjustment. This is quite a serious defect on shipboard.

In the construction shown in the accompanying figures 1 to 8, the inventor employs a pair of condenser plates one of which is covered with a thin layer of mica or light dielectric material, the capacity being varied by the adjustment of the plates in respect to each other; that is, the plates are shifted toward each other so as to avoid a rubbing engagement.

Figure 1 is a top view; figure 2 is a side elevation; figure 3 is a cross sectional view taken on the plane of the line 3-3 of figure 1, showing the condenser plates in a partially separated condition; figure 4 is a similar view showing the condenser plates brought together. Figure 5 is a bottom plan

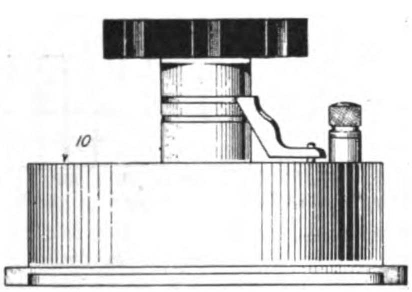


Figure 2—Side elevation

view of the device with the bottom cover removed; figure 6 is a detailed sectional view of one of the binding posts, showing the flexible connection

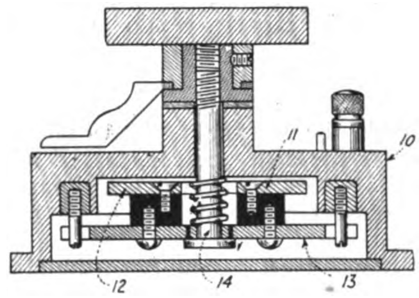


Figure 3—Cross sectional view

therefrom to the movable condenser plate; figure 7 is a cross sectional view of a slightly modified form; figure 8 is a bottom plan view of the main portions of the device and figure 9 shows graphs plotted from some of the results obtained with the device.

In the first form illustrated, a metallic supporting base 10 is provided, made

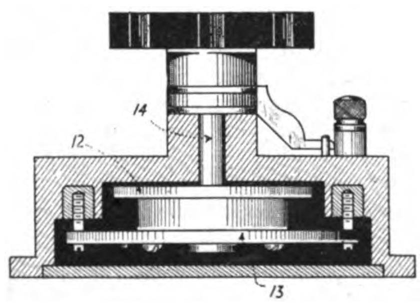


Figure 4—Cross section showing condenser plates brought together

hollow to serve as a casing for certain of the parts, and constitutes a plate or condenser element 11. The second condenser plate is designated at 12 and is shown as housed within the hollow base opposite the condenser surface 11. This condenser plate is insulated from its support by a block of insulating material 13, having a central passage through which the stud 14 extends.

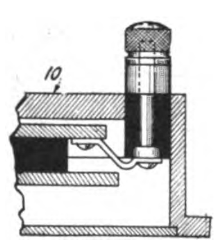


Figure 6—Detailed sectional view of one of the binding posts

A layer of dielectric material is interposed between the condenser plates, mica having been found a desirable material. It is secured to the face of the upper condenser plate in the illustration.

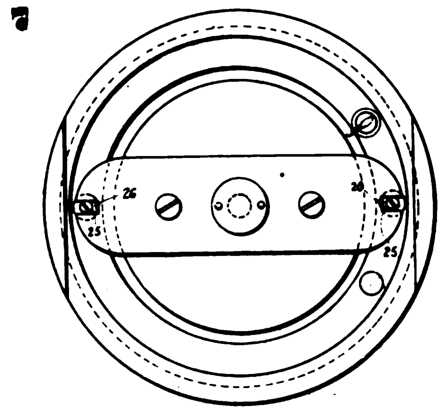


Figure 5—Bottom plan view

The construction illustrated in figures 7 and 8 is similar to the preceding figure, the main distinction being that in the latter form, the hollow base 10' is made of insulating material; this necessitates applying a separate metallic condenser plate 11' to the underside of the base as the opposite element of the movable condenser plate; the secondary condenser plate in this case is secured directly through the operating screw without any insulation.

In this construction, the movable condenser plate is guided in a straight path into engagement with the other condenser plate by forming the guiding slots 26' directly in the peripheral portion to receive the guide studs 25'.

Some of the results obtained from the condenser are shown in the graphs figure 9. The horizontal graduations from 0° to 10° indicate figures on the condenser scale, the vertical graduations indicating the capacity in microfarads. The solid black line indicates results of an actual test using an adjusting screw of thirty-six threads to the inch. The range of control and

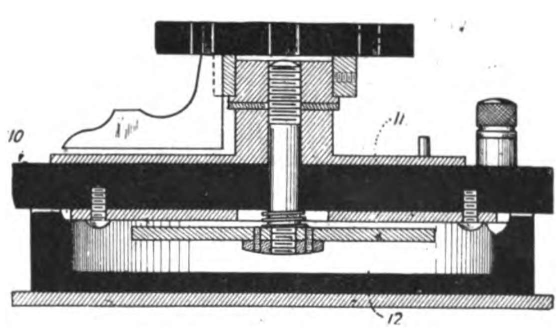


Figure 7—Cross section of a modified form

the ease of adjustment will be apparent from the curve. The dotted line indicates the calculated results using mica of approximately five ten-thous-

andths of an inch in thickness as the dielectric; the dot and dash line indicates calculated results without the mica. The dash line indicates results

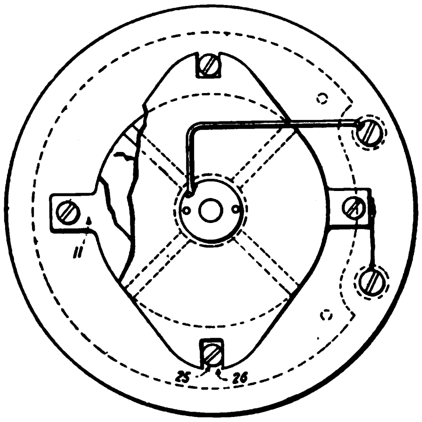


Figure 8—Another bottom view of the main portions of the variable condenser

using an adjusting screw of sixty-four threads to the inch.

The capacity of the condenser without the mica, neglecting edge effect, would be inversely proportional to the separation of the plates. With the one plate, however, covered with mica, (which material has a dielectric constant of approximately six times that of air) the capacity would be inversely proportional to $\frac{M}{K} + A$: where M equals the thickness of the mica, K equals the dielectric constant of mica, and A equals the distance from the outer surface of the mica to the other plate.

It will be apparent from the shape of the solid line curve that this type of condenser is especially valuable for use in a wave meter or in the wing circuits of a vacuum tube detector.

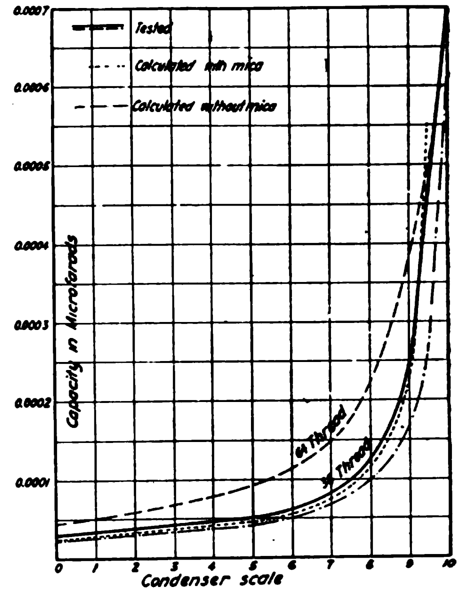


Figure 9—Graphs plotted from some of the results obtained

Locating the Taps on a Tuning Coil for Equal Increments of Inductance or of Wave Length

By Ralph R. Batcher

THE tendency in the past few years has been to replace the sliding contacts on the inductance coils of receiving sets with multi-point switches. It may prove advantageous in some cases to bring out taps from the coil so that each section would add a definite amount of inductance to the circuit. In other cases it would be desirable to divide up the coil so that each section would produce an increment proportional to $\sqrt{L}$; or, in other words, proportional to the wave length λ, since

$$\lambda \propto \sqrt{L}. \qquad (1)$$

For a single layer coil this is readily accomplished. It is necessary first to determine some relation between the inductance of a coil and the number of the turns. Lorenz's inductance formula for a single layer winding is perhaps the most simple one to use:

$$L = r\, n^2\, Q, \qquad (2)$$

where r represents the radius, n the turns, and Q a factor depending upon the ratio of $\frac{\text{diameter}}{\text{length}}$. The factor "Q" is obtained from handbooks for different values of shape ratios.

If it were not for the fact that in a single layer inductance all of the lines of force from each turn do not cut each of the other turns, the inductance would be proportional to the square of the number of turns. The fact is, that L varies as some power of the number of turns less than 2.

Changing equation (2) to read:

$$L \propto n^3 \frac{Q}{n} \qquad (3)$$

and plotting $\frac{Q}{n}$ one gets a curve having the appearance of a hyperbola.

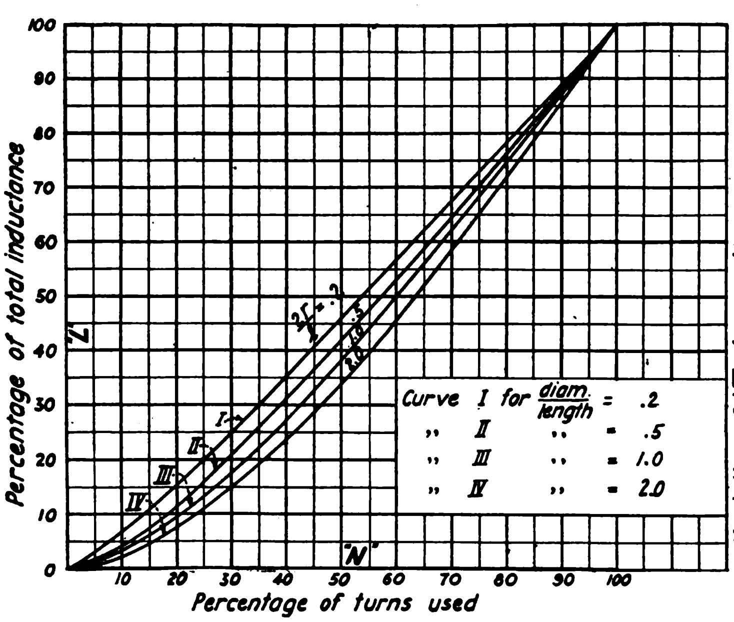


Figure 1

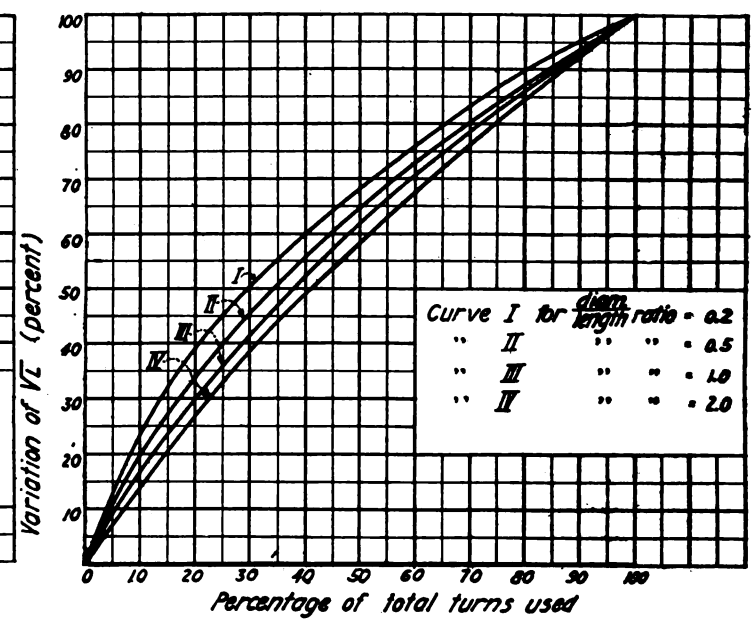


Figure 2

An equation roughly representing (3) deduced from the curve follows:

$$L \propto n\left(1.45 + \frac{\text{length}}{8\ \text{dia.}}\right) \qquad (4)$$

The equation shows that the inductance is more nearly equal to the first power of the number of turns than to the second power.

As this equation is a rather difficult one to use, curves have been constructed to show this relation graphically. To obtain greater accuracy, these curves have been plotted from the original formula rather than from equation 4. The curves represent four values of shape ratios but interpolation for other values of $\frac{\text{diameter}}{\text{length}}$ is a simple matter.

An example of how the curves may be applied in practice is as follows: Suppose it is desired to divide a coil 15.75" long, 7.87" in diameter having 400 turns of wire, into eight sections (the taps leading to a nine point switch), so that inductance could be added by equal amounts. The total inductance of this coil is 12.9 millihenries. Referring to curve II on figure 1:

Tap				Inductance	Millihenries
1	located on	first turn	gives	0% =	0
2	"	" 84th	" "	12.5% =	1.61
3	"	" 138th	" "	25.0% =	3.22
4	"	" 185th	" "	37.5% =	4.83
5	"	" 228th	" "	50.0% =	6.45
6	"	" 272d	" "	62.5% =	8.06
7	"	" 316th	" "	75.0% =	9.66
8	"	" 358th	" "	87.5% =	11.27
9	"	" last	" "	100.0% =	12.9

If this coil were to be used alone as the secondary coil of a receiving transformer, the taps might be taken off according to the curves of figure 2. In this case taps should be taken off from turns 1, 27, 84, 91, 136, 190, 252, 320, and 400. This will insure a constant wave length increment for each additional section of the winding cut in the circuit. (If a secondary loading coil is used these results will not be strictly correct.) Shunted with a .0005 mfd. condenser the wave length on each of the respective points would be: 0, 600, 1800, 2400, 3000, 3600, 4200, 4800 meters, neglecting the distributed capacity of the coil.

Group Frequency Tuner

WHAT we are told by the inventor is a novelty in the wireless telegraph art but which is well understood by wireless engineers is the group frequency tuning apparatus described by John Hays Hammond, Jr., in a recent patent specification.

The transmitting apparatus is shown in the accompanying diagram, figure 1 and the receiving apparatus in figure 2. In figure 1, a source of undamped oscillations B is coupled to a transmitter aerial inductively at the oscillation transformer L-1 and L-2. A resistance changing device such as C (which may be a microphone) is placed near a tuning fork D which can be replaced by any device operating at audio frequencies which is capable of modulating the antenna oscillations. When D is set into vibration, periodical changes in the amplitude of the antenna oscillations occur and consequently the signals can be received by any detecting apparatus responsive to damped oscillations.

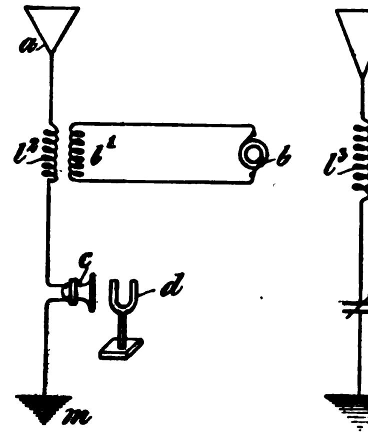


Figure 1—Transmitting apparatus

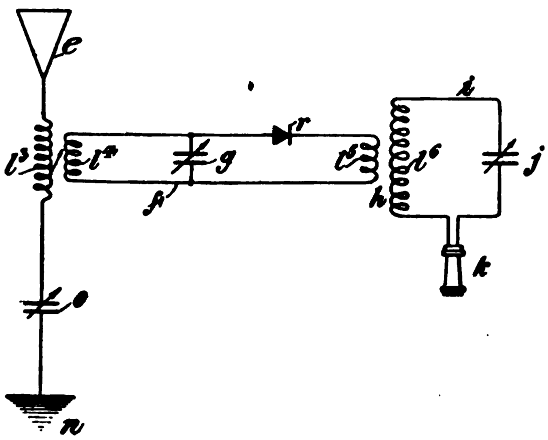


Figure 2—Receiving apparatus

The inventor attaches to his receiving apparatus as in figure 2 an audio frequency tuning circuit comprising the secondary inductance L-6, the variable condenser J and head telephone K. As is possible with all group frequency tuners, selectivity is obtainable not only by radio frequency tuning, but by audio or group frequency tuning as well, that is, for best response the operator must vary the natural frequency of the audio frequency circuit L-6, J, K, as well as adjust the radio frequency tuning elements of the receiving transformer. The inductance of L-6 is obviously very large for the frequency 500 cycles.

What Is the Most Efficient Receiving Set for Amateur Use and What Should Be the Dimensions of the Aerial and Tuning Coils?

THERE are many short wave regenerative receiving sets on the market, all of which are as good as present-day knowledge of radio telegraphy can make them; but for the benefit of the experimenter who prefers to assemble the apparatus himself, I am presenting the hook-up and dimensions of what is, in my opinion, the most efficient short wave receiver.

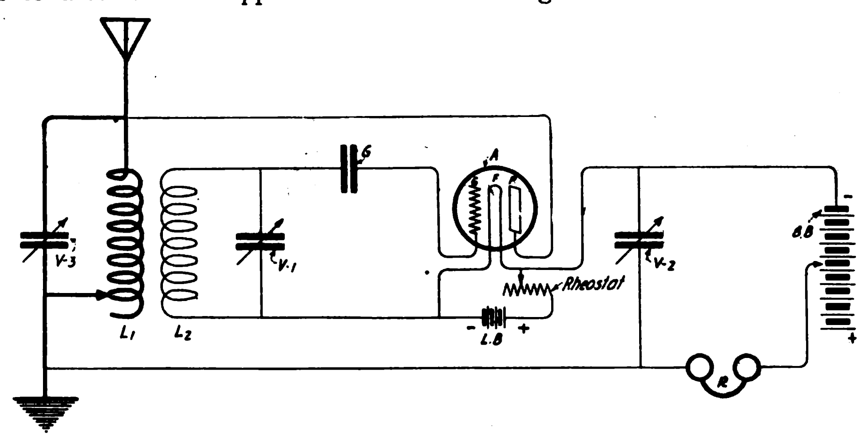


Figure 1—Circuit for the amateur receiving set

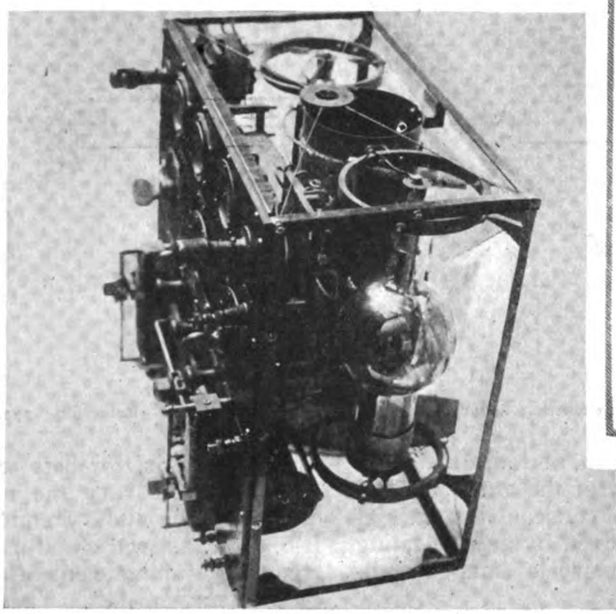
A receiving set for short waves should have low resistance, stability of adjustment, reliability and be easy to operate. It should be highly selective and is preferably fitted with an end-turn switch.

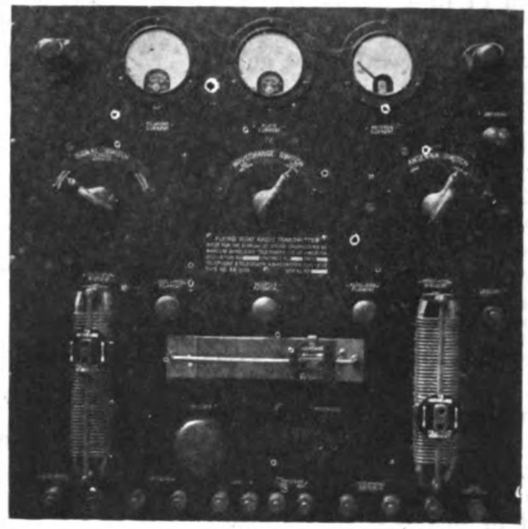
The Aerial

If a well balanced, efficient receiver is desired, the size and location of the aerial must be taken into consideration, as well as the other components of the receiving set. An aerial of the following dimensions will be found most satisfactory—4 to 6 No. 14 bare copper wires, spaced three feet apart, one hundred feet long and sixty feet high. The aerial may be supported by different means, but for strength and durability, I have found that a mast consisting of three joints of 20' iron pipe, of 3", 2" and 1" diameters respectively, connected by reduction

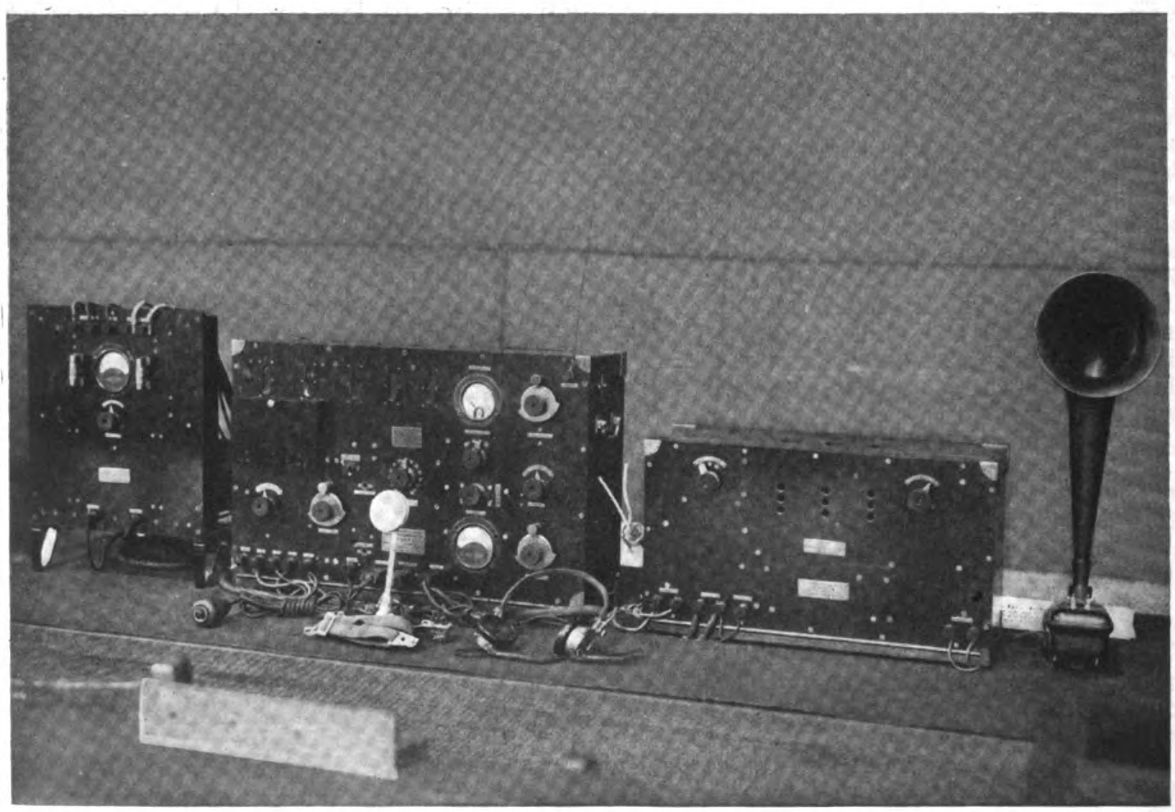
Wireless 'Phones

Photos, Intl. Film.





To the left: An interesting view of the Marconi transmitter used on naval flying boats, showing the arrangement and installation of the vacuum tubes and the means of control. Above: A front view of the same set showing the registering devices and control handles. At the top are the ammeters for filament current, plate current and antenna current; the three switches below are for the following purposes: the Signal Switch effects the change from telegraph to telephone; the Wave Change Switch changes the radiated wave from 600 to 1600 meters; the Antenna Switch has the usual send and receive positions. The rheostats regulate filament current and are respectively connected to oscillator and modulator



The radio ground set and amplifier of the Signal Corps as exhibited and demonstrated at the recent New York Aeronautic show

couplings and well guyed to be permanent and substantial. After coupling the sections together, drive an eight foot, creosoted, locust post securely into the base of the mast, about two feet, so that when the mast is raised it will be supported on the post, which should be set three feet in the ground. This insulates the mast fairly well, preventing radiation losses to the ground when transmitting.

The aerial should be located so that no trees, smokestacks, wires, buildings or other objects are directly under it, as these will cause some loss of energy, both in transmitting and receiving. The lead-in should be taken from one end, because if it is brought from the center it causes the aerial to sag, spoiling its appearance. The fundamental wave length of such an aerial is a little below 200 meters, making it possible to tune to amateur wave lengths without resorting to the use of a series condenser, and on the other hand it is large enough to permit efficiently the reception of 600 meter wave lengths and above provided a vacuum tube detector is employed.

Receiving Transformer

The loose coupler L-$_1$ and L-$_2$ in figure 1 should have enough wire to tune to 600 meters but not so much as to cause a dead-end loss when receiving 200 meter stations. The primary should consist of 60 turns of No. 18 S. C. C. copper wire wound on a tube 3½" in diameter and 6" long. The dead-end losses of this primary are negligible, rendering the use of dead-end switches unnecessary. The secondary should be wound with 125 turns of No. 24 copper wire on a tube 3" in diameter and about 6" long, taps to be taken off every six or eight turns. Precise tuning may be accomplished by the use of a small variable condenser, V-1 across the secondary.

Variable Condensers

Two condensers (variable) are sufficient for this set, but another condenser V-3 should be connected across the primary if close variation of the primary wave length is desired. Condenser V-2 should be a 43 plate, oil-immersed, rotary variable, while V-1 may be of 19 or 23 plates, not oil-immersed. Fixed condenser G is the usual grid condenser.

Detector

The valve A should be of the tubular type, and one which oscillates readily. It is sometimes difficult to obtain uniform oscillations from the bulb at high frequencies. The lighting battery L, B, for the filament is preferably a storage battery as it will prove much more economical in the long run than dry cells, because the filament draws a considerable amount of current. The high potential battery B,B may consist of ten three-cell flat, flashlight batteries, as these are compact and have long life. In place of regulating this battery, cell by cell, by means of a rotary switch, a high resistance potentiometer gives closer regulation. It should be connected in shunt with the cells being connected as any potentiometer.

Telephones

The mica diaphragm amplifying receivers are by far the most sensitive for wireless reception; they are also the least uncomfortable to wear for long periods and they fit the ears closely enough to exclude outside noises. If the cost of these is prohibitive, however, I would recommend any standard make of 2,000 ohm telephones.

Connections

All connections should be as short and as direct as possible. No. 18 wire is satisfactory. After the set is connected up, the aerial, ground and lighting battery connnections should be reversed until the best results are obtained.

Operation

The valves should be adjusted to a point below where a hissing sound is heard in the head telephones. This is the most sensitive point. This set is not affected by the proximity of the operator's hand or body, as in the Armstrong circuits, making it unnecessary to use long adjusting handles. For general "listening in," the coupling should be close, but by judicious use of the coupling when receiving through heavy QRM or QRN much of the interference can be eliminated.

It has been found that a magnet placed near some bulbs in a certain position, will increase its sensitiveness. The operator must determine by trial the correct position for the magnet.

It is to be noted that I employ regenerative coupling but instead of coupling the plate to the grid circuit, I connect to the antenna circuit, with equal results and with greater simplicity of operation.

The above described apparatus, connected according to the diagram will fulfill all the requirements for a simple, reliable and efficient receiving set for amateur wave lengths.

J. E. Law, Jr.—*West Virginia.*

A Variable Condenser Adapted for Small Variations in Capacity

IN the ordinary type of variable condenser it is difficult to obtain a fine adjustment of the capacity values because a slight movement of the movable plate causes a considerable change in capacity. N. H. Slaughter has devised the variable condenser shown in figures 1, 2, 3 and 4, which permits a very close adjustment of its capacity.

He provides two sets of movable plates, one set comprising the bulk, which may be 10 or 20 in number, the other set having only a small number of movable plates, say 1 or 2. These sets are independently movable and both

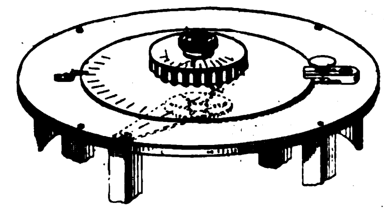


Figure 1—Top view

sets may be adjustably interleaved with the stationary set.

The construction is such, that the larger set of movable plates may be adjusted in any position to roughly give the desired capacity; and then for purposes of finer adjustment, the smaller set of the plates may be rotated to give the exact capacity desired.

In the drawings, the semi-circular plates 13 are approximately the same in number as the stationary plates 1. The

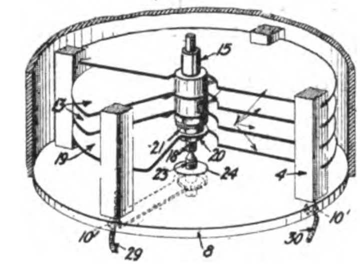
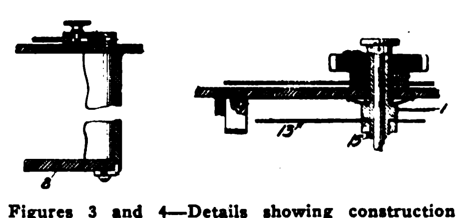


Figure 2—Interior view

shaft 15 is hollow and placed within the same is a shaft 18, to the lower end of which is clamped a single blade 19. This blade which provides for fine adjustment, is held in position by the shaft 18 by means of the clamping nuts 20 and 21 which are inserted on the shaft 18.

Both of the movable sets of plates are carried by the shaft 18, the lower end of which is adjustably supported by the set screw 23, which is threaded in the bushing 24 in the bottom 8.



Figures 3 and 4—Details showing construction of frame and rotating shaft with semi-circular plates attached

Electrical connection may be made to the system by means of the lead 29 which is electrically connected to the movable plates by means of the set screw 10' which serves as a binding post. The other terminal is a lead 30, one end of which is electrically connected to the stationary plate by means of the set screw 10' which is screwed into the lower end of the standard 4.

The Design of 60-Cycle Transformers for Amateur Transmitters

(*Continued from page* 26)

With steel laminations .014 thick, a core 1.7 inches will require $1.7 \times 59 \times 4 = 404$ pieces in all; 202 of these should be cut 1.7 inches wide and $(5.2 + 1.7) = 6.9$ inches, say 7 inches, long. The other 202 pieces should be cut 1.7 inches wide and $(3.4'' + .1.7'') = 5.1$ inches, say 5 inches, long. The builder may be able to get these cut to these dimensions by the manufacturers of the steel.

We may now determine the efficiency of the transformer from the foregoing formula. Summarizing,

Primary copper loss = 8.36 watts
Secondary copper loss = 7. watts
Iron loss = 15.36 watts

$$\text{Therefore, Efficiency} = \frac{500}{500 + 15.36 + 8.36 + 7} = 94\%$$

Assembly

Stack up the laminations as in figures A and B and be sure to stagger the joints. Drive nails in a board as in figure C and lay on sheets until the pile is 1.7 inches thick. The ends of the cores are shown in figure D. Figure E shows how the yokes will appear finally. After making up two cores and one yoke like figure C, bind them with one layer of friction tape.

Next put 1/16 inch washers on primary and ⅛ inch washers on the secondary. These should be made of micanite. Next place the micanite tubes on the primary and secondary cores. Make them about the same thickness as their respective washers.

The winding form for the primary is 1.8 inches on side and 5 inches long. Put on one layer of fishing twine, then one layer insulating paper, and finally 238 turns of No. 13 DCC wire. Now take off one end of the form, pull out fishing twine, whereupon the coil will come off very easily. Next solder on 1 foot of No. 12 machine cable to act as leads and then dip the coil in clear insulating varnish and bake for about 6 hours. Then wrap it with one layer linen tape, lapping the tape for half its width and then place the coil on the core. This completes the primary.

The form for the secondary will be 1.9 inches square and 1.2 inches long. First wind it with cord and paper as the primary, and put on 85 layers of 85 turns per layer of No. 30 D.S.C. wire. Place 1 layer of .007 inch oiled paper between the layers, then solder on leads of No. 20 silk covered lamp cord. Now remove the coil from form and wrap it with one layer of empire cloth. Construct the other three coils the same way.

The builder may be able to get these coils wound by some manufacturer of armature and field coils. The wire should be wound very carefully in even layers. It may be better to allow a little of the paper to extend beyond the ends of the winding as in figure F.

To finish the job, place the four coils on the core and connect up as in figure G. Be sure to connect the sections so the current travels around the core in the same direction. Place the remaining yoke in position, carefully watching the ends. Secure the core with oak clamps and bolts as in figures H and I.

The transformer should be placed in a tank and the leads brought out through suitable bushings. The secondary bushings should have an insulating value of at least 20,000 volts. Fill the tank with transil oil and put on a suitable cover.

The transformer has a leakage reactance suitable for a condenser of .008 mfd. using a quenched gap. When used with a non-synchronous gap the number of studs times the R.P.S. of the gap motor should not exceed 400. A method of finding suitable condenser values for various transformers will be discussed in an article on resonance to follow.

Contest Winners for the May Issue

In response to the call in the March issue for manuscripts concerning "The use of a quenched spark gap in connection with an amateur's 60 cycle transmitter," prizes have been awarded to the writers of the following articles

First Prize—The Quenched Spark Discharger Is Not the Most Desirable from the Amateur Standpoint

NO one who understands the principles of radio engineering doubts that the quenched spark discharger is the most efficient gap yet devised for low powered transmitters. The writer, however, will attempt to show that the amateur in the majority of cases is not in a position to take full advantage of the benefits thus to be obtained, and as a consequence a non-synchronous rotary spark gap is the one to be preferred for amateur use.

In the first place, many amateurs are of the opinion that simply to substitute a quenched gap for one of the plain rotary type will result in increased antenna current and range of transmission; but it is safe to say that those who have tried to experiment have been amazed at the degree of *inefficiency* which the quenced gap brought about! In all probability it will be found that such amateurs have never been told the requirements of a radio transmitter that gives good quenching. It is not alone the quenched spark gap that prevents the interchange of energy between the open and closed circuits with the consequent double wave emission, but it is the design of the whole transmitter which must be considered.

To begin with, there must be a certain amount of magnetic leakage in the power circuits of the transmitter, for otherwise when the condenser discharges across the spark gap, the transformer is short circuited and the resulting arc at the gap is too powerful to be quenched out. This permits the antenna circuit to react upon the spark gap circuit and results in a double wave emission. This is substantially what the amateur with the average 60 cycle transmitter will find.

A transformer fitted with a magnetic leakage gap will give some relief; even the insertion of a reactance coil in the primary circuit of the transformer will help some, but the best results will be obtained with a transformer having a magnetic leakage gap and utilizing the principles of resonance; that is, the transformer circuit with the secondary condenser should be tuned near to resonance with the frequency of the alternator.

The operation is then somewhat as follows: Due to resonance, the secondary voltage of the transformer rises to the point where the spark gap breaks down. The resistance of the spark gap is then reduced and the secondary of the transformer is short circuited. This throws the transformer circuits out of resonance with the alternator, resulting in a very marked drop in the secondary voltage This drop in voltage combined with the heat dissipating qualities of the copper plates in the quenched gap permits the primary to oscillate only through two or three swings, whereupon the primary oscillations increase. The antenna circuit then oscillates at its own frequency at damping with a single wave emission.

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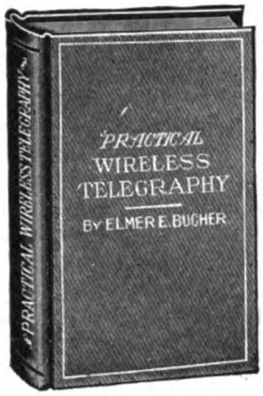

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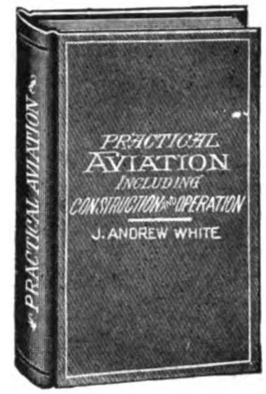

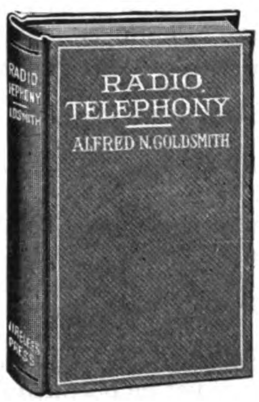

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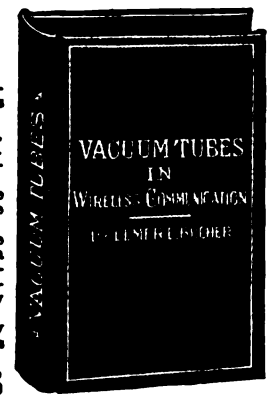

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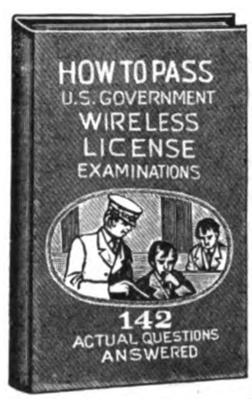

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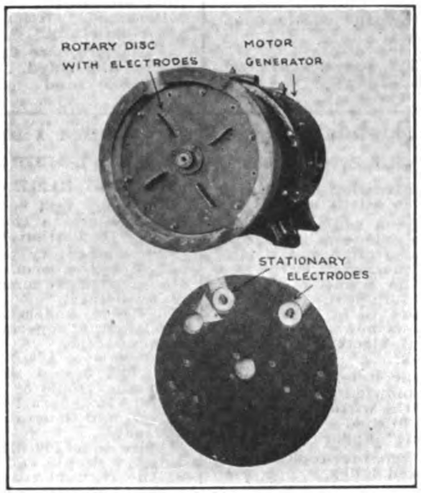
Wireless Press, Inc., 25 Elm Street, New York City

Experiment has proven that it is difficult to maintain a clear spark note with a resonance transformer, hence the natural frequency of the transformer circuit with its secondary condenser is designed to be 15 per cent or 20 per cent lower than that of the alternator. This prevents the breaking up of the spark note and still retains enough of the good effects of resonance to obtain the detuning results mentioned. In some types of transmitters like the Marconi quenched spark sets, the necessary magnetic leakage takes place at the alternator, the transformer being closely coupled; but since the amateur has no control over the source of power, he is required to obtain the necessary leakage at the transformer.



Synchronous rotary spark gap giving the high pitched note desired by amateurs

Suppose, for example, he possesses a transformer with a magnetic leakage gap and desires to operate near to the point of resonance. The necessary condenser capacity can be readily obtained in the following way: An ammeter is placed in the primary circuit, the key closed and the capacity of the secondary condenser varied until the primary ammeter reads the maximum. This indicates resonance. Then the capacity should be increased by 10 per cent to 15 per cent in order to slightly detune the circuit. With some types of transformers, the necessary capacity for resonance, or near resonance, may exceed .01 mfd. and as a consequence the amateur cannot operate on the wave length of 200 meters. If this is found to be the fact, he may obtain some relief by placing a reactance coil in series with the primary circuit of the transformer, using it, as well as the secondary condenser, to tune the circuit. By giving proper attention to the foregoing suggestions, very good results can be obtained with the quenched gap. There is, however, one all important factor that has not yet been taken into account.

Some experimenters are of the opinion that a quenched gap will increase the frequency of the spark discharge. This is not true. The quenched gap has the effect of smoothing out the tone of the spark, but at best the resulting spark note will be relatively low and will hardly compare with the musical note of non-synchronous rotary spark gap which amateurs are accustomed to employ. The average 60 cycle transmitter gives, with a quenched gap, what is known as a "mush" note, which, while it may be pleasing to some ears, cannot be said to be the most desirable tone. There are no ready means available to increase the tone of the spark except the type of transmitter which involves both a rotary spark gap and quenched gap. Some experimenters have placed these gaps in series using the rotary gap to increase the tone, and the quenched gap to give the necessary quenching. Experiments in circuits of this type do not always give the desired results. In fact the writer has found that the system is not very efficient.

This discussion, of course, does not include the rotary quenched spark discharger which has been supplied to the amateur market, but the writer has observed that these transmitters have such a large capacity in the closed circuit that they cannot be operated efficiently on a wave length of 200 meters. Such a large capacity results from the use of a low voltage secondary, usually no more than 2500 volts, but if it were not for that disparaging feature, it is safe to say that it would be employed universally by amateurs; for it is well known that a set of this type now supplied to the amateur market produces a spark tone equivalent to a 500 cycle transmitter.

Another item which experimenters should take into account is the cost of the quenched spark discharger. It has been the writer's experience that the expense of milling, cutting and casting the plates for quenched gaps exceeds the cost of a good rotary gap; and moreover, unless the amateur is willing to put the best possible construction into the quenched gap, he will find that it will not operate over a considerable period of time without trouble.

The average wireless experimenter prefers a high pitched spark note, or at least a note equivalent to a non-synchronous rotary gap. The writer has yet to see the quenched gap operated on 60 cycle current that will give a note equivalent to the non-synchronous rotary gap.

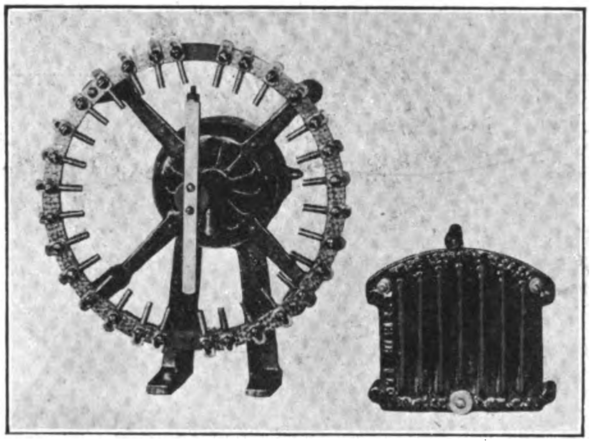
This discussion, of course, does not apply to 500 cycle transmitters, but since the amateur has not available a source of current of this frequency, the use of such frequencies need not be considered.

The writer firmly believes that in the future the approved transmitting set for amateur use will be one of the vacuum tube type, because these transmitters are rugged, fairly efficient, can be connected up to generate radio and audio frequency currents simultaneously and thus produce musical tones so desirable for all-around wireless transmission. No one has yet put such a transmitter on the market, but it is safe to say that one of these types will appear in due time.

A. J. HOLBORN, *New York.*

Second Prize—Arguments Against the Use of a Quenched Spark Gap in Connection with an Amateur's 60 Cycle Transmitter

IN spite of the fact that the stationary quenched spark gap is considered to be one of the most efficient types of spark dischargers, it has not been extensively used by amateur experimenters. This is probably due to the reduced efficiency of the gap when operated on 60 cycle transmitters of the type amateurs are accustomed to use.



Non-synchronous rotary gap suitable for use with 60 cycle transmitters

A transmitting circuit containing a quenched gap operates somewhat on the principle of impulse excitation; that is, the oscillations of the condenser circuit are rapidly damped out by the quenching action of the gap, allowing the antenna circuit to oscillate at its own natural period. The gap operates most efficiently when the spark frequency of the condenser circuit is around 1,000 per second. At this frequency the oscillations of the condenser circuit, which are rapidly damped out by the quenching action of the gap, transfer impulses of oscillating current energy to the antenna circuit at a very rapid rate. In the case of a 60 cycle transmitter where the spark frequency of the condenser circuit is low, say 120 per second, the condenser circuit will transfer impulses to the antenna circuit at a very much lower rate with greater current at each impulse than in the case where the higher frequency is employed. This will increase insulating difficulties in the antenna circuit.

Many transformers used by amateurs are unsuitable for use with quenched gaps. The voltages in a great many cases are too high. When the spark frequency is high, the quenched gap has been found to operate most efficiently on low voltages which the amateurs cannot use, if they desire to employ the amount of power permitted by law.

The note of a quenched spark transmitter used with 60 cycle current is very low when heard at a distant receiving station. Furthermore, it has been proven by several radio engineers that currents of high frequencies around 1,000 per second will produce the same effect in a telephone receiver as currents, many times as great, at lower frequencies. Therefore, the receiving operator may hear a comparatively weak signal from a low frequency spark transmitter while a signal from a high frequency spark will be heard much louder, even if the received energy from both transmitters are the same. For this reason, a high pitched note has a great advantage over a low pitched note; and in some cases, a higher spark frequency will completely drown out a low pitched spark, simply because the telephone receiver is less sensitive to a low note than to a high one.

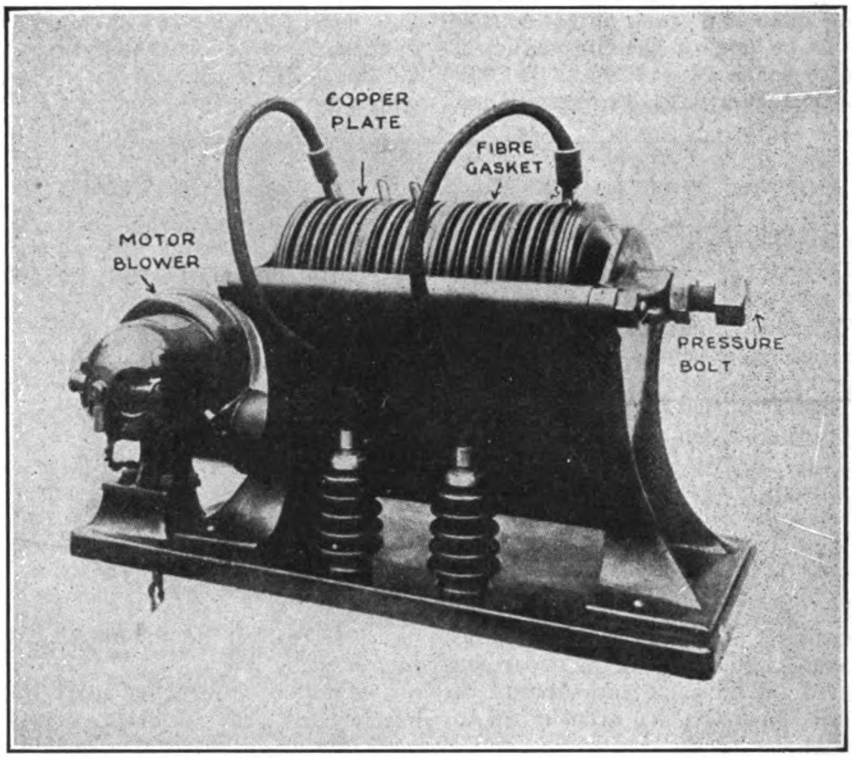
It is more difficult to receive a low pitched note through atmospheric disturbances. The higher pitched note of a non-synchronous rotary gap can be read with much greater ease; but it cannot be obtained from a 60 cycle quenched gap.

CARL DIETSCH, *Ohio.*

Third Prize—The Quenched Spark Gap and the 60 Cycle Transmitter

THE post-war restrictions imposed upon amateurs regarding power input will require the amateur to strive with increasing zeal to gain the highest possible efficiency out of his apparatus. The quenched gap, possessing as it positively does, 25 per cent greater efficiency than any other form of gap, will be used by the amateur to a greater extent Such a transmitter will probably have a greater range under those conditions than one employing the rotary gap.

The superiority of the quenched gap is recognized by the commercial companies and the U. S. Navy, who use it to the almost entire exclusion of other forms, and the amateurs will profit by following a good



A quenched spark gap of improved efficiency

than heretofore, if he is willing to sacrifice the spark note.

As is well known, 60 cycle current is not favored for signaling, due to its low frequency and unmusical pitch; the quenched gap will not improve that pitch. Reception is more difficult through static interference as compared with the more musical sparks of higher frequency and the reception of rapidly transmitted signals with low frequencies becomes rather difficult at great distances. This accounts for the popularity of the non-synchronous rotary gap, in which the spark discharges occur at the rate of 200 or 300 per second along the initial 60 cycle alternating current curve. But during the times of favorable atmospheric conditions and times when the ether is free from interference from other stations, as in midnight hours, very long distance work should be accomplished with a well balanced quenched spark transmitting set using 60 cycle alternating current. example. A lower transformer secondary voltage can be used and the better quenching properties of this gap permits of closer coupling between the closed and open circuits, resulting in greater antenna current per given power input at approved decrement per oscillation. The noiseless qualities of the quenched gap should also be given consideration. A primary reactance may be employed to advantage to regulate the voltage of the primary current to secure synchronous discharges.

In summing up, we find that practical considerations oppose the electrical efficiency of this combination, but the latter no doubt exceeds the former. At least a greater number of amateurs should experiment along these lines, as intelligent results can be noted only from practical application to long distance work. Possibly the progressive amateur will provide both the rotary non-synchronous and the quenched gap, using each according to conditions.

HUGO L. ESTBERG, *New York.*

The Monthly Service Bulletin of the

National Wireless Association

Founded to promote the best interests of radio communication among wireless amateurs in America

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IMPORTANT NOTICE

All restrictions upon the use of wireless receiving stations, other than those used for commercial traffic, were removed on April 15th. The order applied to amateur, technical, experimental, and other stations. Restrictions on transmitting stations of all types remain in effect.

New England Gets Started

THE first post-bellum meeting of the New England Amateur Wireless Association was held at the Everett High School on February 13, with an attendance of about seventy-five. G. R. Entwistle presided.

A very interesting talk was given by Arthur Batcheller, New England Radio Inspector.

All amateur licenses both "operator" and "station" have been automatically canceled, and when stations are licensed again, new call letters will be assigned. This step is necessary to avoid confusion.

In order to secure a first grade amateur license one must be able to both send and receive not less than ten words a minute, and must also pass a technical examination.

The radio inspectors will visit the principal cities at certain periods notifying holders of these licenses two or three weeks beforehand. These men will be expected to appear and take an examination for a first grade license. Those who do not appear or advise the inspector of their inability to do so, will be regarded as no longer interested and their licenses will be canceled.

The law regarding interference will be as strictly enforced among amateur stations as it now is among commercial stations.

The fact that the majority of New England's 2,500 licensed amateurs enlisted, speaks strongly in favor of continuing amateur radio. These men were enabled to take up their duties without special training, thereby saving the government a vast amount of time, which was at such a premium in those strenuous days when every second counted. A committee was appointed to secure permanent quarters for the club.

The association would like to hear from its old members, also from those interested in becoming members. Communications should be addressed to the secretary, Mr. P. W. Pratt, 100 Harvard St., Everett, Mass.

Until further notice a meeting will be held once every two weeks.

Suggestion for Prize Contest, June Issue Wireless Age

We will pay the usual prizes of $10, $5 and $3, in addition to our regular space rates, to the three contributors who send us the best manuscripts on the following subject:

"To what extent do you believe that wireless telephony will take the place of wireless telegraphy in amateur communications?"

Death of Harry V. Roome

Amateur wireless lost an ardent supporter and generous co-worker by the death of Corporal Harry V. Roome of Los Angeles. According to word received by his mother the young soldier died September 30 of gunshot wound and pneumonia.

Corporal Roome was called in the first Selective Service summons and went to Camp Lewis, where he was en-

gaged as wireless instructor. Later he went to France and saw active service in the Signal Corps. The last letter written by him was dated September 15. Corporal Roome was a graduate of the University of Southern California.

A Voice From the Rhine

NOW that hostilities have ceased and peace is in sight, it is urged that amateur stations be permitted to reopen immediately. The most important reason is, that it trains the young amateur for war-work as was clearly shown in the past two years. While we do not expect another war to follow immediately, this is an age when preparedness is an important factor and the United States should never be caught again so wholly unprepared to defend the rights of her people. I was a radio operator in the Army throughout the recent conflict and it has been a matter of keen interest to me to note how well the former amateur played his part and how comparatively inefficient was the man without any previous wireless experience. Practically all the former commercial operators were needed at their old positions and it was up to the amateur to play the leading rôle which he did in every radio organization I have come in contact with.

Now as to the commercial side of the argument, it is evident that with the improvements that have been introduced of late, radio will become an important rival to the wire lines. This expansion will require operators which can only be obtained in sufficient numbers from the ranks of the amateurs. It is a fact that our best commercial operators today were formerly amateurs.

Then the shipping trade resulting from the war is going to be materially increased and every ship will require one or two operators. There are many former wireless "bugs" that with a little brushing up on their amateur practice could fill any of these positions. So it would be much better to give these men a chance than to fill these positions with so-called operators picked up hit and miss regardless of their qualifications.

There is yet another phase to the question. Radio makes an interesting diversion for the high school boys. Not only do they get many hours of interesting play out of wireless experimenting, but the technical education they thus obtain is of inestimable value. Every amateur must have an inkling of the theory of radio which of course, involves a knowledge of electricity. Other branches of electrical work offers many opportunities to young men, so that even if the amateur never intends to follow wireless as a profession, he has secured a store of electrical knowledge which would serve him equally well in many other lines.

Any one of these reasons alone would justify the government to lift the ban on amateur stations and to reissue licenses, which I believe will be done as soon as a permanent peace becomes more certain and the pressure of other measures allows the question to be acted upon.

In respect to power input, one kilowatt is sufficient, but stations should be allowed to use a longer wave length. The primary reason why they were before limited to so short a wave length was to eliminate interference with commercial stations that were working on slightly longer wave lengths. Nearly all the newly constructed commercial stations are operating on long wave lengths and it must follow that all stations will change to the longer wave. This should allow the amateur to use at least 600 meters because a 1 kw. station will work most efficiently between 400 and 600 meters.

PVT. HOMER G. JORDAN—*A. E. F. Germany.*

For Those Who Sent the "Age" Overseas

TO THE EDITOR:—Many, many thanks for printing my letter requesting recent issues of THE WIRELESS AGE. I was surely remembered by many of the old boys and received over 20 copies, which I sent to radio men over here. I wish I was a writer; I would surely give you a lot of dope on how wireless was used in the war. I have studied all methods of communication. I have seen how the English, French and the Germans do it. I even tried hooking an aerial, consisting of six wires, to the balloon basket 2,000 feet high. No, don't laugh! It got results. The cable from the balloon to the winch makes a wonderful aerial.

It was great to hear all the broad wave sets in a sector. Talk about the amateurs on a busy night! They had nothing on this. You see, every company has a small transmitting set such as the S.C.R. 54. It has a broad wave and when about 30 of these get agoing, you know what happens. . . . Get my drift?

Wishing big success to the best radio magazine in the world—THE WIRELESS AGE—I am,

JOSEPH E. ENGSTROM (2 A. S. O.)
24 Balloon Co., Air Service
St. Mihiel, France.

Marconi and Fleming Support British Amateurs

MARCONI, inventor of wireless has again proved himself the amateur's friend. In the Wireless World, of London, appear his opposition views to proposed legislation in Great Britain which would prevent amateurs experimenting with wireless telegraphy. "I wish to state that, in

my opinion, to follow such a course would be a mistaken policy," says Mr. Marconi. "It should be borne in mind that in many or, perhaps, in all branches of radiotelegraphy finality has by no means been reached, and I consider that the existence of a body of independent and often enthusiastic amateurs constitutes a valuable asset towards the further development of wireless telegraphy. It is wise also to remember that had it not been for amateurs wireless telegraphy as a great world-fact might not have existed at all. In the United States, for example, a great deal of the development and progress of wireless telegraphy is due to the efforts of amateurs.

"I think, therefore, that the suppression of the work of those amateurs who are interested in wireless telegraphy would be against the public interest."

Dr. J. A. Fleming, inventor of the famous Fleming valve, also makes a strong plea for the amateur:

"Now that the war is happily ended we ought as soon as possible to be freed from certain shackles of bureaucratic control and from any restrictions which were essential for national safety during the progress of the struggle. One of these is the permission under license to conduct research in radiotelegraphy and telephony. At the outbreak of the war all private and university radio stations were dismantled and non-official research stopped. The question then arises—how soon will these restrictions be removed? It is a matter of common knowledge that a large part of the important inventions in connection with wireless telegraphy have been the result of amateur work and private research, and not the outcome of official brains or the handiwork of military or naval men. In fact we may say that wireless telegraphy itself in its inception was an amateur product. At the time when Senatore Marconi first made known his epoch-making inventions the official telegraphists of the General Post Office had been working for years and spending large sums of public money in trying to develop and exploit the magnetic-induction and earth-conduction methods of wireless telegraphy of very limited application, but, apart from certain pioneer work by Admiral Sir Henry Jackson, they did not succeed in utilizing electro-magnetic waves for this purpose until Mr. Marconi showed them how to do it.

"Then, again, numerous important inventions such as the crystal detectors, the oscillation valve, the three-electrode valve, the electric arc generator, the high-frequency alternator-directive radiotelegraphy, beat reception, all the important uses of the thermionic detector, and much work on the study of atmospheric stray waves, has been due to private or amateur expert work, and not to official electricians in the General Post Office or the Army or Navy. If, then, full opportunities for such non-official work and research are not soon restored, there is no question that the progress of the art of radiotelegraphy and telephony will be greatly hindered.

"In an article published by me just eighteen years ago in The Nineteenth Century and After (February, 1901) entitled 'Official Obstruction of Electrical Progress,' I pointed out how much of all electrical discovery and invention has been due to amateur work, including in that term teachers and private investigators of all kinds.

"The action of Government officials has been in most cases to hinder and not help progress. As a rule the most effective method of afflicting any department of applied science with lethargy is to constitute it a Government monopoly."

Queries Answered

Answers will be given in this department to questions of subscribers, covering the full range of wireless subjects, but only those which relate to the technical phases of the art and which are of general interest to readers will be published here. The subscriber's name and address must be given in all letters and only one side of the paper written on; where diagrams are necessary they must be on a separate sheet and drawn with India ink. Not more than five questions of one reader can be answered in the same issue. To receive attention these rules must be rigidly observed.

Positively no Questions Answered by Mail.

R. R., Wapinitia, Ore.:

Ques. (1)—Which is the most efficient, an open core transformer or a closed core transformer, both having the same power input?

Ans. (1)—If properly designed, they are equally efficient, but the open core transformer is more expensive to construct, because it requires more material than the closed core transformer for a given power input.

Ques. (2)—What would be the wave length of an 8 wire antenna, 60 feet in length, 38 feet in height at one end and 43 feet in height at the other end?

Ans. (2)—Approximately 135 meters.

A. P., Winthrop, Mass.:

The first receiving set you describe has a range of wave lengths up to 2,000 meters, the second set will respond up to 3,500 meters and the third set up to wave lengths between 6,000 and 8,000 meters. You will require loading inductances in the primary and secondary circuits of the second set to receive the longer wave lengths radiated by high power stations. It is difficult to conjecture your receiving range unless we know the type of oscillation detector you employ.

A vacuum tube regenerative set using a single bulb, will permit reception over very great distances provided the apparatus is correctly designed and an aerial of fair proportions is employed.

H. R., St. Augustine, Fla.:

If you can procure a vibrator that can handle the primary currents of four induction coils, we would suggest that the primaries be connected in parallel, making sure that the current for all four coils passes through the vibrator. The secondaries may be connected in series or in parallel, depending upon the condenser capacity employed.

* * *

A. W. J., Warren, Pa.:

Pages 281 and 282 of the text-book "Practical Wireless Telegraphy," give complete dimensions of a long wave receiving set. The dimensions of the regenerative coupler are approximately those used for a 3,000 meter tuner, that is, the secondary coil may be about 5½ inches in length, 4 inches in diameter wound with No. 26 S. S. C. wire and the primary of similar length, but about 3½ inches in diameter wound with No. 26 S. S. C. wire.

The variometer type of coupler described in your third query will respond to wave lengths up to 700 meters.

The variometer mentioned in the first query should be wound with No. 28 wire in order that the tuner may respond to 3,000 meters.

* * *

C. F., Jersey City, N. J.:

The correct number of plates for the condenser mentioned is best determined by experiment. For one thing, inasmuch as you do not intend to place glass between the conducting plates, you will have to space the plates sufficiently to prevent the transformer discharging between them. With a 20,000 volt transformer, two banks in series are required. The capacity should not exceed .008 mfd. and a dozen of the plates you mention connected in parallel with two sets in series should give the proper capacity.

* * *

C. K. U., Ancaster, Ont., Canada:

If the receiving station to which you intend to transmit possesses a thoroughly sensitive oscillation detector, you should have no difficulty in covering a range of 10 miles with a 2-inch or 3-inch spark coil.

The poles to support the antenna need not be more than 30 feet in height. They should be spaced about 100 feet. Four copper wires spaced 2½ feet apart will be satisfactory for the flat top portion of the antenna. Either hard drawn or stranded copper wire may be employed.

The lead-in wire does not necessarily have to be placed in a vertical position, but it should be run as directly as possible to the station house. A complete transmitting and receiving apparatus to cover the distances you require should not cost more than $20 to $25.

* * *

J. A. B., Annapolis, Md.:

The filament current of various types of vacuum tubes varies with the construction. Some tubes require an ampere or an ampere and a half, while others will operate with ¼ or ½ ampere in the filament circuit.

Replying to your second query, the inductances in the X circuit of the Weagant receiver employs the same size wire used in the secondary circuit, although it is not strictly essential that the same size wire be employed.

Regarding the control of the plate voltage in the vacuum tube detector: To prolong the life of the plate battery, the most satisfactory method of controlling the voltage is to connect the cells to a multi-point switch varying the applied E.M.F. by a cell at a time. Either a series resistance or a shunt resistance may be employed. The shunt resistance should be approximately 3,000 ohms while the series resistance may have to be considerably greater, depending upon the internal resistance of the tube. Most amateurs prefer the cell by cell adjustment of the plate voltage.

C. B., Union, Ore.:

Any of the advertisers in The Wireless Age can supply you with raw material for constructing a wireless transmitter and receiver. Various types of cabinet receivers have been described in past issues of The Wireless Age. The set designed by Fearing Pratt in the April issue of the Wireless Age consists of three receiving sets and you can select the one most suited for reception in your district.

The text-book "How to Conduct a Radio Club" gives dimensions of receiving tuners for various ranges of wave length. The dimensions of the coupler depend upon the wave lengths you intend to receive.

* * *

D. C., Ann Arbor, Mich.:

We presume that station licenses will be issued to amateurs just as soon as peace articles are signed. Experimenters are now permitted to operate their receiving sets, but they cannot use their transmitters until the ban is lifted.

* * *

F. S. F., Chicago, Ill.:

In a forthcoming issue of The Wireless Age, there will appear a complete description of a vacuum tube transmitting and receiving set which employs one bulb for both purposes. Dimensions and other data for construction will be given.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912.

Of The Wireless Age, published monthly at New York, N. Y., for April 1, 1919.

State of New York, }
County of New York. } ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared E. J. Nally, who, having been duly sworn according to law, deposes and says that he is the President of the Wireless Press, Inc., publisher of The Wireless Age, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher, Wireless Press, Inc., 25 Elm St., New York, N. Y.

Editor, J. Andrew White, 25 Elm St., New York, N. Y.

Managing Editor, None.

Business Manager, Alonzo Fogal, Jr., 25 Elm St., New York, N. Y.

2. That the owners are: (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent or more of the total amount of stock.)

Wireless Press, Inc., 25 Elm St., New York, N. Y.

E. J. Nally (851 shares), 233 Broadway, New York, N. Y.

•3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.)

None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

E. J. NALLY,
President.

Sworn to and subscribed before me this fourth day of April, 1919.

(Seal.) M. H. PAYNE.

(My commission expires March 30, 1920.)

June, 1919

20 Cents

The WIRELESS AGE

Volume 6 Number 9

Examining the Instruments Prior to an Aerial Overseas Flight

A Full Description of the Marconi Wireless Telephone for Seaplanes

The Wireless Age

Edited by J. ANDREW WHITE — E. E. BUCHER, Technical Editor

Vol. 6 — No. 9

Contents for June, 1919

Index of Equipment

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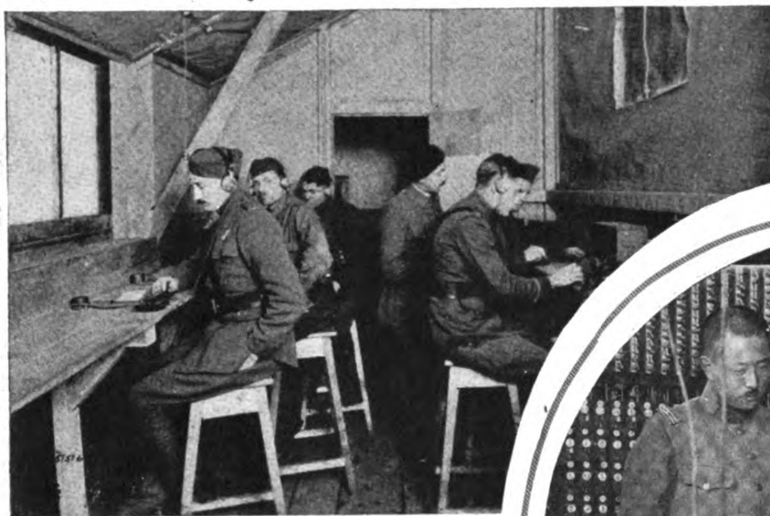
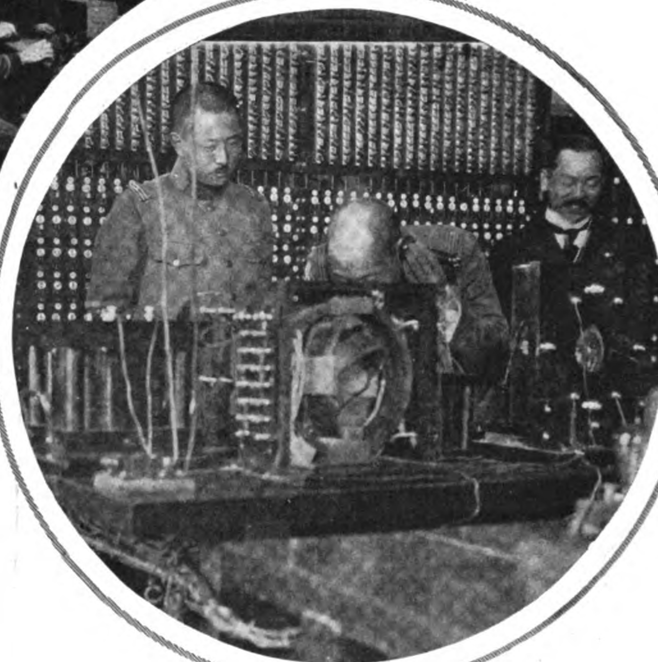
GREAT BRITAIN, Marconi House, Strand, London — AUSTRALIA, 97 Clarence St., Sydney, N. S. W.



A group of observers at Le Valdahon, Doubs, France, getting in some wireless practice during spare time; novices are thus taught to send and receive, and experienced operators increase their skill

U. S. Official Photo



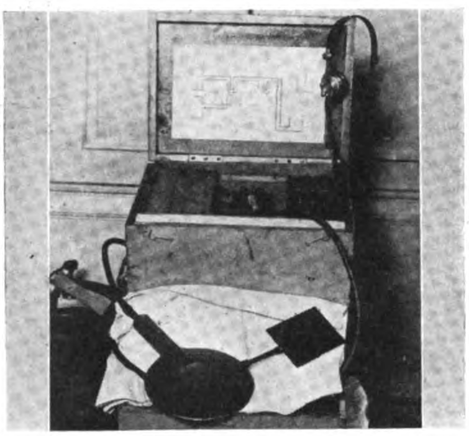
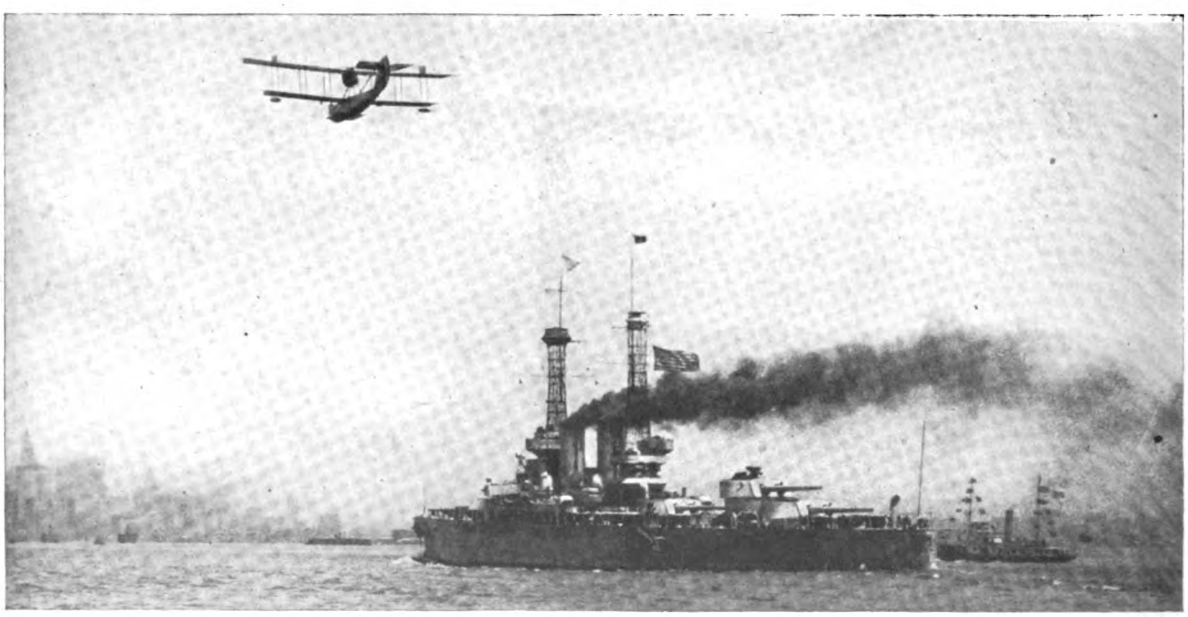


Photo: Press Ill. Svce.

In uniform, standing, in the circle above is H. I. H., Prince Kita-Shirakawa inspecting the wireless apparatus at Tokyo Central Telegraph office, as a complimentary message is being received from Guam

To the left is the hydrophone submarine detector used successfully during the war as a means of detecting the approach of enemy undersea craft



As the homecoming fleet sailed into New York an invitation from the reception committee was transmitted and the plans were approved and accepted by wireless

Photo: Press Ill. Svce.

Vol. 6. No. 9. June, 1919

THE WIRELESS AGE

WORLD WIDE WIRELESS

Growing Importance of Wireless Recognized

THAT the future for wireless is great and a belief that it will play a large part in reconstruction are thoughts expressed in a recent copyrighted dispatch from London to the N. Y. Sun. According to the writer, in a discussion of wireless and reconstruction Guglielmo Marconi noted that the war had done wonders for wireless. Never have so many kindred inventions been made in so brief a period as have sprung up in connection with wireless since the war started. As indicated by the fact that a message recently was sent half around the globe, wireless will have a tremendous role to play in the days of reconstruction.

Only those who know the cost of maintaining a line of telegraph across the wastes of the desert, through the jungle, across the wilds of the tropics, can have any appreciable idea of the saving that wireless will effect.

Tornadoes, even the ants, work havoc among telegraph wires. That this evil will be largely surmounted by wireless goes without saying.

Wireless will have a far greater part to play in connection with the great aerial routes with which the continents are to be linked up.

Wireless will have opportunity to display its powers in linking up those parts of the country intersected by waterways. The money spent in laying cables, in defraying the expense of upkeep and so forth, is amazing.

One thing upon which Marconi lays stress is the part his invention will play in fostering international relationships. He is profoundly grateful for what wireless achieved in the cause of freedom during the war, just as he rejoices over the thousands of lives saved by his invention before the war, to say nothing of the many rescued during the hostilities.

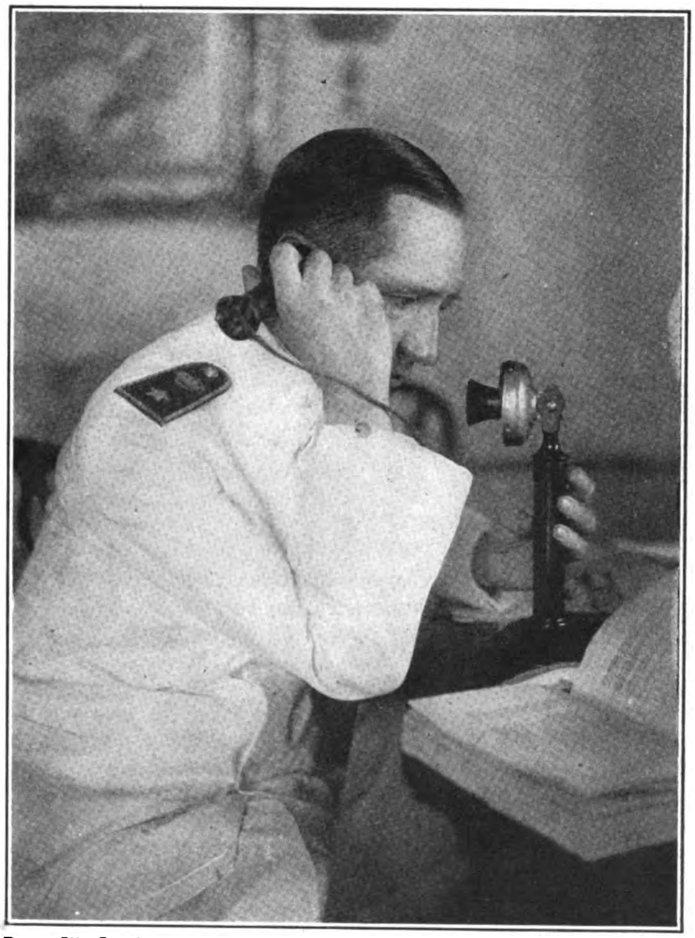
But the part it is to play during the day to be will best accentuate the utility of the invention of Marconi. Shipwreck will be a peril not half so terrible as it was till recent years. Opinions soon will be bandied about the earth in a way that seems incredible. Consultations between the world's statesmen, scientists, business heads, will constantly be in progress; the mountain ranges, the far-flung frontier line, the oceans, will be reduced into the compass of a few leagues.

The development of aircraft will be assisted by wireless in a way that baffles the imagination., Until recently an airplane or an airship enveloped in fog was more or less out of touch with the surface. Especially was this the case at sea, where many an able pilot came to a tragic end. But now lost in a cloud bank the aviator of today by wireless can be as certain of his bearings as if he were the skipper of a paddle steamer.

In the event of a great earthquake the wireless will be of even greater assistance than ever it was. In combination with aircraft, wireless would be the means of summoning assistance on such an occasion with startling promptitude.

And the same holds good in regard to railway collisions.

The telegraph has played the leading part in bringing many a criminal to justice. But an infinitely greater trap for the culprit will be the telegraphy which, independent of the innumerable restrictions of wires, can play a greater part in arresting his flight than telegraphers ever dreamed of.



Press Ill. Service
Recent portrait of Marconi, who sees great expansion in peace-time uses of wireless

German Peace Delegates Use Eiffel Tower Wireless

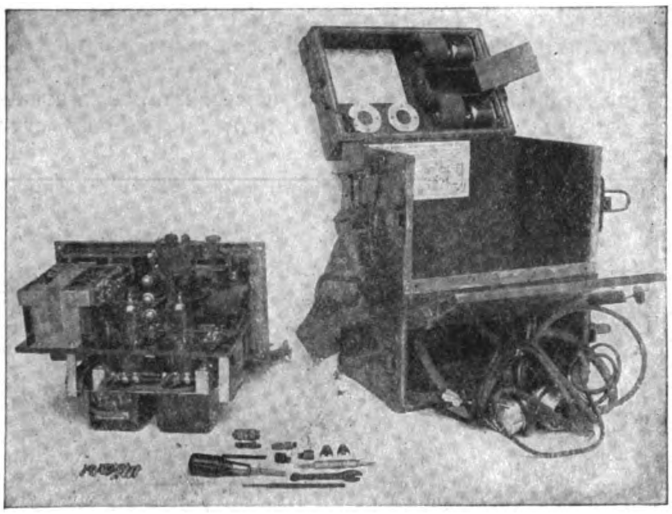
FOLLOWING the news of the presentation of the peace treaty it was stated that the high-power radio equipment in the Eiffel Tower had been reserved for the exclusive use of Count Brockdorff-Rantzau, head of the German peace delegation, at certain hours during the day. The announcement of this arrangement from Versailles added that a direct wire had been established from the Hotel Des Reservoirs to the famous French long-distance station.

International Commission to Distribute Radio Information for Aerial Navigation

THE proposed convention regarding international aerial navigation has been completed by the judicial and military sub-committees of the Aeronautic Commission of the Peace Conference, on which Brig.-Gen. Benjamin D. Foulois, Major Pollock and Capt. Bacon represent the United States.

The convention is composed of forty-one articles, which establish an international agreement on sovereignty of the air, provide for the concession of inoffensive voyages between the contracting states and deal with forbidden zones and also international aerial routes.

An international commission on aerial navigation is to be formed. Its duty will be the gathering and disseminating of radio-telegraphic, meteorological and medical information affecting aerial travel.



Ground telegraph transmitting and receiving apparatus

Voices By Radiophone Urge Purchase of Victory Notes

FROM an airplane flying 2,600 feet overhead an army officer read President Wilson's Victory Liberty Loan message to 15,000 persons assembled at the south steps of the Treasury, in Washington, by the use of the wireless telephone and a newly invented sound amplifier.

The throng of Government employees, dismissed for the capital's opening demonstration for the loan, cheered the President's message as spoken through the air and enunciated distinctly to them by Lieut. H. E. Metcalf, a radio officer in the airplane.

The "sound amplifier," was also given its first public demonstration in Victory Way, in New York.

The external evidences of the instrument were sound distributors, resembling phonograph horns in shape, suspended from wires over the heads of the crowds. The voice of a speaker given in at the central transmitter is amplified and carried with equal force to each of the sound distributors in the system.

Used in conjunction with the wireless telephone, sound was brought from a city wireless station and then reproduced over the overhead wires. Voices and phonograph and piano music were recorded.

Franklin D. Roosevelt, Assistant Secretary of the Navy, was one of those who spoke; his words were received by wireless telephone from Washington.

Visitors also had the official naval time transmitted to them every quarter hour in the same manner as the navy wireless station at Arlington flashes the correct time to ships at sea. Other features included the transmission of a soldier quartet singing at Camp Upton.

Overhead the big navy dirigible C-4 from the Rockaway station sent down a telephone message to the crowd to "buy Victory notes."

Wireless Warning Saved Leviathan from Floating Mine

THAT the transport Leviathan, biggest ship afloat, carrying 14,000 persons including troops, crew and civilians, came within ten yards of striking a mine on her way from Brest became known when the ship docked at Hoboken.

A wireless from the transport Mount Vernon on April 21st reported a floating mine 400 miles southeast of the Grand Banks. The Leviathan swerved southward, but at 10:30 o'clock the next morning her lookout reported a mine so close that when Lieut. Commander Harold Cunningham, the navigator, put the ship hard to port she missed the mine by only thirty feet.

Naval Academy's Electrical Head Takes Charge of French Station

CAPTAIN A. St. Clair Smith, U. S. N., has been ordered from the Naval Academy at Annapolis to take command of the Lafayette Radio station conducted by the U. S. Navy at Croix d'Hins, near Bordeaux, France.

The station, which is nearly completed, has eight towers, each 850 feet in height. The control of the Croix d'Hins station, it is understood, ultimately will pass to France.

Captain Smith has headed the Department of Electrical Engineering and Physics at the academy for two and a half years.

Croix de Guerre for Brooklyn Wireless Man

FOR maintaining his wireless station in the midst of the famous "million dollar barrage," Private Edgar T. Smith, of Brooklyn, has been awarded the Croix de Guerre. Smith was a wireless operator on a New York-Havana liner prior to enlisting May 4, 1917. He was assigned to the Signal Corps as an instructor in wireless signaling at Camp Upton. When the big drive started September 27, Private Smith was in charge of a wireless detail in the second line trenches of the Argonne. Six men were holding a station that invited shelling through the German's use of instruments locating wireless stations. As soon as the drive started and the wireless orders began snapping from the station the detail was located.

German guns were trained on the dugout where the detail was stationed and after a few close shots a direct hit knocked it to bits. Instead of going back the detail moved a half kilometer forward. Private Smith with three men established another station closer to the enemy guns. The other two men went out for food and Smith operated the station for 24 hours alone.

On February 27, at Ballou, the 37th Division, the Ohio National Guard, of which Smith was then a member, was reviewed and presentations of decorations made. With a kiss on each cheek he was given the Croix de Guerre for "distinguished bravery."

Smith was twice gassed and once wounded with shrapnel. He fought in the Vosges, St. Mihiel, Meuse-Argonne and other sectors.

British Admiralty Removes Ship Radio Restrictions

ACCORDING to an announcement from the British Admiralty all restrictions on the use of wireless telegraphy on ships were removed on May 1st except in the North Sea, the English Channel east of the line joining Dungeness and Boulogne, in Baltic Northern Russia, in the waters of the Mediterranean, Black Sea, and Sea of Marmora.

Directional Effect of Radio Useful in Trans-Atlantic Aircraft Flight

PROFESSOR W. I. SLICHTER, of Columbia University, is the author of an interesting article which appeared recently in the New York World, dealing with one of the many cases where the development work in preparation for war may be put to permanent use in the arts of peace.

In transoceanic flight a difficulty will be encountered in that it is impossible to take an observation of the sun from an airplane, as is the universal custom among mariners in order to determine their position at sea. The reason for this difficulty is the mariner measures the angle between the sun and the horizon to determine his position, and the horizon is a definite thing to one located within a few feet of the level of the sea. But to an observer in an airplane the horizon changes with every change in altitude, and in order to make a careful calculation the observer would have to know his height above the sea very accurately and then make very complicated calculations.

That is why radio engineers are so interested in the problem of transoceanic flight; because they have a scheme by which the aviator may determine his position at any time of the day or night, in fog and cloudy weather as well as sunshine. In this it has an advantage over the present practice of the mariner.

To assist the transoceanic flyer it is necessary to have two or three powerful land radio stations, such as at Washington, D. C., Newfoundland, Ireland and France, send out signals of a definite strength at definite intervals, say once an hour. The operator in the airplane could by means of the well known directional effect of the radio direction finder determine the direction of any two of these stations and thus locate himself on the map by finding the intersection of two lines drawn in the proper direction from the two land stations. Two stations are all that are necessary theoretically, but as the plane might be travelling on the straight line connecting them, he would not always be able to tell his distance from his objective without a third.

It is to be hoped that in the two transatlantic flights about to be attempted in the very near future by an English aviator in one direction and an American navy aviator in the eastwardly direction this scheme will be tried. It is still in doubt, as radio engineers have not as yet attempted to reach great distances to airplanes.

Patent Claim Is Basis for Injunction Against Alien Property Custodian

THE General Transmission Company, a New Jersey concern has brought suit in the equity courts to enjoin the Alien Property Custodian and the Secretary of the Navy from paying any money to the Atlantic Communication Company and the New York Patents Exploitation Corporation on account of the use of certain wireless apparatus by the government, the patent on which is said to belong to the General Transmission Company. An accounting is asked for.

Hammond Wireless-Controlled Torpedo to Have Final Test

IT is announced from Washington that Colonel Robert S. Abernathy, a field artillery officer has been ordered to Boston as official representative of Secretary Baker, in connection with preparations for final tests of the wireless-controlled torpedo invented by John Hays Hammond, Jr., which Congress has authorized the War Department to take over if it fulfills expectations.

Selection of Site Made for Dutch Wireless Station

THE site for the wireless station intended for communication between the Netherlands and the Dutch East Indies has finally been decided. The selection made is the Koelberg hill, which is 86 meters high and located in Hoog-Buurlo, near Apeldoorn.

A new railway line will be constructed from Kaatwyk. The station is to have four towers, each 210 meters high, a large power house and building for housing the operatives. The communicating station in India is to be built near Bandoeng in the Preanger, so that the distance between the two stations will be some 11,000 kilometers.

Int'l Film Service

The "Magnavox"—meaning great voice—a device for amplifying wireless telephone speech

Engineers Believe Commercial Radio Telephony Offers No Complications

THE belief that radio telephony will be established commercially as a complement to the wire systems by means of which remote and inaccessible points may be reached, was expressed in a paper prepared by E. B. Craft and E. H. Colpitts of the Western Electric Company, and read at the convention of the American Institute of Electrical Engineers.

The paper described the work accomplished in the development of wireless telephony in the war, and called attention to its advantages and disadvantages as compared with the wire system. One of the principal advantages is that the wireless system would require neither fixed nor accessible channels, and no cost at all for line construction and maintenance.

"It is easy to see," the paper said, "that radio telephony could never compete with wire telephony in densely populated districts, while wire telephony is a physical impossibility at sea and in the air. Connection of a wire system to a radio system is no more complicated than connecting wire lines and therefore these two fields, although distinct, are adjacent."

Harvard Naval Radio School Comes to an End

THE naval radio school established at Harvard University during the war has been closed and the personnel and equipment transferred to the school at the Great Lakes naval training station.

Orders have been published detaching Commander David A. Weaver from duty at the Harvard school and assigning him to the Great Lakes station.

Wireless Service to West Indies Opened

THE Naval Communication Service has opened commercial traffic between St. Thomas, St. Croix, San Juan, Santo Domingo and Port-au-Prince and the United States via the Naval Radio Station at Guantanamo and cable from Guantanamo to the United States. Traffic will be accepted in the United States for West Indian points.

Direction Finder Locates Ship with Great Accuracy

ONE of the best records yet made by radio direction finding stations on the Atlantic coast was hung up by the Hog Island and Cape Henry stations on April 7th when they located the battleship Virginia, inbound with returning troops, several hundred miles off the coast, their estimate being within a mile of the ship's actual position.

According to the navigating officer of the Virginia the big battleship was plowing along through a dense fog, and no bearings had been taken for some time. Then the radio began to click and Cape Henry's position was located. A few minutes later Hog Island broke in and its direction was noted. Then a line drawn on a chart from Hog Island until it met a similar line drawn from Cape Henry pointed to the ship's location. Bearings taken a few minutes later proved the radio had come within a mile of the Virginia's actual position.

The officers of the Virginia, who have had considerable experience with the radio finding plants on the European side were amazed at the accuracy with which Cape Henry and Hog Island located the big transport.

Scene of Early Morse Experiments Now Has Wireless

WITH the installation of powerful U. S. wireless equipment at San Juan for transoceanic service, Porto Ricans are recalling that the electric telegraph had its first tryout in Porto Rico. Morse, the inventor, conducted many of his experiments at Cuatro Calles, in Arroyo. The terminals of his experimental line were the house he occupied and a warehouse in the same village.

Signal Corps Calls for Radio Men

THE Signal Corps, U. S. Army, is urgently in need of radio operators, according to the statement issued simultaneously from various recruiting headquarters. Cable and telegraph operators, telephone and telegraph line men, pigeon fanciers, and a number of other specialists are also required. The men are needed for Alaska, Philippine Islands, Panama, Hawaii, and for service in the United States.

All Canadian Amateur Restrictions Removed

FROM Ottawa, Canada, on May 5th came the long awaited news that the war-time regulations canceling all licenses issued for the operation of amateur wireless stations throughout the Dominion, have been rescinded. This decree frees experimental stations which have been inoperative for more than four and a half years.

Full Scope of German War Plotters' Radio Work Exposed

FRANCIS P. GARVAN, recently appointed Custodian of Enemy Alien Property to succeed A. Mitchell Palmer, designated by President Wilson for United States Attorney General, has made public the latter's report on the work of the office since America entered the war.

Of the wireless seizures, the report says:

It must have been apparent to the Germans that communication with America would be cut upon England's entry into the war, unless some means independent of cable or ship was established.

The war plotters found in a transatlantic wireless station the sole means of overcoming the British control of the seas and of maintaining their touch with America, and from 1910 to 1914 there were begun and completed two high-powered wireless plants, one at Sayville, L. I., and the other at Tuckerton, N. J.

Investigation of the wireless field disclosed that the Telefunken system had been installed on German shipping and on our own coastwise fleets, and had been operating with great success in conjunction with the Sayville plant. German stations had been installed in Cuba, Mexico, Central and South America. A high-powered plant had been erected at Togu, Africa, and China and Dutch East Indies and also the Pacific Islands had been sprinkled with Telefunken ship-to-shore stations.

An American appearance had been given to Telefunken in America by the organization of the Atlantic Communication Company and the naming of a directorate of American citizens. The technical work, however, and the disbursement of moneys were in the hands of German agents. Telefunken engineers came over to install the plant and operate it.

Despite the immediate cutting of the German cables and despite Great Britain's vast preponderance on the sea, Germany was able, while a ship floated, to keep in touch with it, and was able to begin at once the effort to influence American opinion.

Navy Offers Training Course to Experienced Men

AN unusual opportunity is offered by the Navy Department at the radio school in Cambridge, Mass., to men between the ages of eighteen and twenty-five years, who have some knowledge of radio work and who are able to send or receive ten words a minute. Applicants for this course must pass a creditable examination in spelling and penmanship and must understand elementary arithmetic. The course covers a period of six months and the subjects taken up during the course are magnetism, static electricity, current electricity, electromagnetism, alternating current, generators and storage batteries, motors and motor control, radio power circuits, oscillatory circuits, spark transmitters, detectors, service receivers, audions, high frequency measurements, review and examination for specialization. The Navy is offering this course, including all the text books and appliances for practical training, free to young men who meet the requirements for enlistment in this school.

By an order of Rear Admiral Victor Blue of the bureau of navigation, commanding that 160 men be sent from the Atlantic fleet each week to the naval radio school at Cambridge, it is believed that the school will remain at its present location until late this summer. The school was originally scheduled for transfer to the Great Lakes station at Chicago, next April.

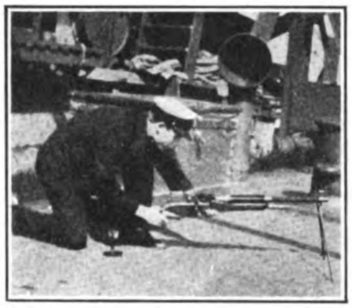
Those enrolled at Cambridge in the future will be regularly enlisted members of the navy and will replace operators in the reserves, now serving on United States merchant ships.

Overseas in the Marconi Service

By George H. Fischer, Jr.

Sailor take care, Sailor beware,
Many brave hearts are asleep in the deep.
So take care, take care . . .

THE little phonograph down below in the gunners' quarters squeaked away. A group on the poop were playing "acey ducey." A crap game was in full sway amidships. Nowhere could be found a less worried bunch of sailors. Most of them just couldn't take this "daw-goned" war at all seriously. Time and again they had crossed the war zone without even seeing a "sub" . . . they reckoned that submarine stuff was all exaggerated anyhow.



The author with machine gun on board the Westwego

But they didn't know they had a jinx with them this trip. A jinx that always worked two ways: brought the trouble, and escaped it, too. The jinx was me.

From the time when Uncle Sam first rolled up his sleeves and entered the war until the day Germany collapsed, I never made a trip to sea without having something happen. Even on my very first trip through the war zone as an enemy of Germany a submarine threw a scare into us. On that occasion there were no torpedoes. The arrival of another ship upon the scene was responsible for that escape.

Now I was on another ship bound for France. It was on board the old Westwego that I had stowed my bag this time. She was a great ship to carry oil; but to carry men—well the men were the last consideration. The reserve coal bunker, aft and just alongside the engine room, had been converted into gunners' quarters. The heat of the month of August was added to that of the engine; the gunner's gloryhole could scarcely be termed a comfy spot. But there never was an American crew of gobs that could stay grouchy no matter what kind of a ship they were on. The usual merchant ship crew of square heads are always grouching. If they aren't they're sick. But all was harmony on our old crab as we nosed eastward through the summer sea.

On all sides were scattered the ships of our convoy; every allied nation was represented. Our consort was H.M.S. Roxborough. Each of the twenty-four vessels in the fleet was bearing a precious cargo to France to feed the machine that was slowly but surely overpowering the Hun. On the other side of the sea were a few hundred submarines. We had no illusions about their manifests; their cargo was a death-dealing one, to be used in an effort to cut off the ever increasing stream of supplies flowing to France. We knew the record. Sinking non-fighting ships without a moment's notice. Murdering crews in cold blood.

As we neared the war zone, radio warnings came in ever increasing numbers. I found an old chart of the North Atlantic and on it recorded the various submarine "position reports" as they were received. On the fourth day of September we were steering due east. Wireless reports received during the night had all been put down on the chart, each sub indicated by a dot. These dots now formed a semicircle, into the very centre of which we were headed. Land's End called the cruiser with a code message that afternoon, and an hour later we were headed west. This maneuver had us all puzzled, and only those on the cruiser knew the truth of the situation.

At noon the next day we once more headed east, and this time we were accompanied by eight large British destroyers which had came up at daybreak from the south'ard.

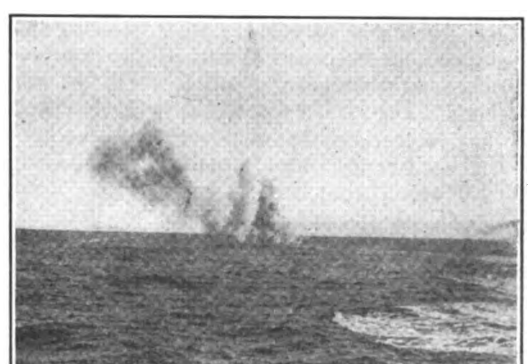
It was wonderful weather for a sea trip. The sea was dead calm and the air not too warm. The afternoon dragged away. The phonograph squeaked worse than ever, for the same needle was still doing duty. Eight bells of the afternoon watch clanked, and died away.

Suddenly, a dull boom sounded from across the water. The cruiser fired an answering shot. Then came a great explosion which shook the whole vessel. We were torpedoed! No; we were safe; it was the ship right off our quarter; the torpedo had passed under our stern.

"General Quarters!" The gunners crowded on the gun platforms eager for a shot at the attacking submarines. A periscope came up for a moment right astern, but our guns were silent; they could not be fired because of the risk of the shell ricochetting and striking a T.N.T. ship which was right behind us. Those of the crew not on watch crowded to the boats and made ready to let go. I was in the radio room and could see only aft, but what I saw was enough to occupy my entire attention. A tanker, the Messina I believe, had been hit in the forward section and was sinking very fast. The torpedo had torn away half her bow; she rose to a vertical position with her propeller churning the air; poised for an instant and then plunged beneath the waves. . . . Two little boats were left bobbing on the surface; many little black

Gun crew at drill. Machine gun in foreground

3-inch gun mounted on poop deck

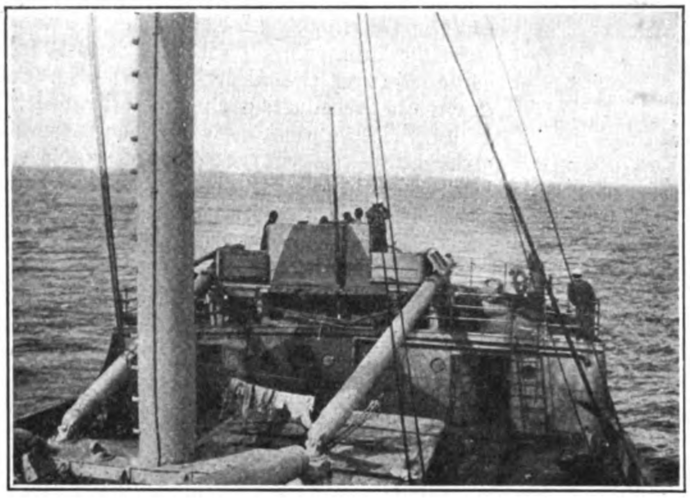


Explosion of smoke producing bomb for smoke screen

specks scattered about reminded us that all had not had time to get to the boats. The very smallness of the struggling forms made the great expanse of water seem greater.

Off to the left was another sinking tanker. She was going down by the stern, not so quickly as the Messina. A destroyer dashed past us, headed for a spot of oil on the surface. Three "ashcans" went over her side. The first and second of these depth bombs brought up great columns of water, but the third must have struck home for the water came up black with oil and wreckage.

The official report said there had been six submarines in the attacking force, the first to make a massed attack. There was no confusion. I still do not know positively how many ships were sunk, but there wasn't a very great



Camouflaged gun platform and crew firing at target

number in the fleet that proceeded up the channel. We sat up all through the night and drank coffee: it was lukewarm in the cups, but coffee in any form was acceptable to men from whose faces had faded the "I should worry" expression. In its place had appeared the tense fixedness of grim determination to square accounts with Fritz at the first opportunity.

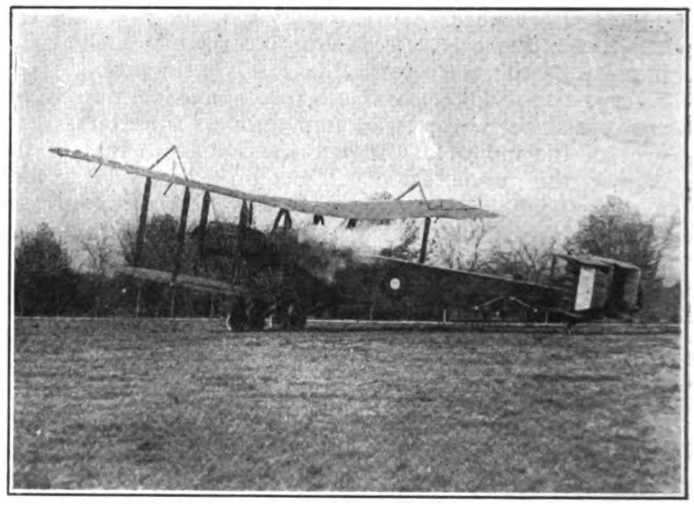
We arrived at Dunkerque, France, two days later, after a short stop-over at Folkstone. Events on our trip across had impressed us with a hatred for the Boche; but that which followed seared that hatred into our souls.

Dunkerque, the one time third port of France, we found a busy military centre. Its devastation lacked the completeness of towns further up the line, but ruined buildings everywhere reminded one that a war was being waged close by. There were two aviation bases at Dunkerque, one French and one English. Our cargo, fuel for the airplanes, was greatly needed. Aerial activity had been unusually great during the past week and frequent raids were taking place. I will endeavor to describe for you one of these raids as it appeared to a merchant mariner.

All day long airplanes had been going and coming from the north; at times the sky held so many that it was impossible to count them. As evening approached, we observed planes going off toward the front lines in small fleets. These, we were told, were bombers. Great giants they were, painted dark grey. As we were approximately twenty miles, possibly less, behind the battle line as it was at that time, it was possible for us to see considerable of the aerial activity in that direction. Along about five o'clock in the afternoon we noticed that a fleet of planes which had left Dunkerque shortly before was being shot at from the German side. Little white puffs of smoke were bursting all about them. Soon the aircraft became mere specks in the sky and we had to use glasses to follow them. Another group of specks—Germans—were seen to be mounting into the sky. In a few moments both groups met and an aerial battle was in progress. It was too far distant to be observed distinctly, but we felt the thrill of each daring maneuver and silently applauded each burst of machine gun fire.

Orders came for us to move. An air raid was expected and there was too much danger of the Westwego being blown up by a bomb from overhead. We were taken out for the night to an anchorage about a mile below the lighthouse. Near by were anchored two British monster monitors, just returned from bombarding the German positions on the Belgian coast. As luck would have it, part of our crew were on liberty and had been left ashore.

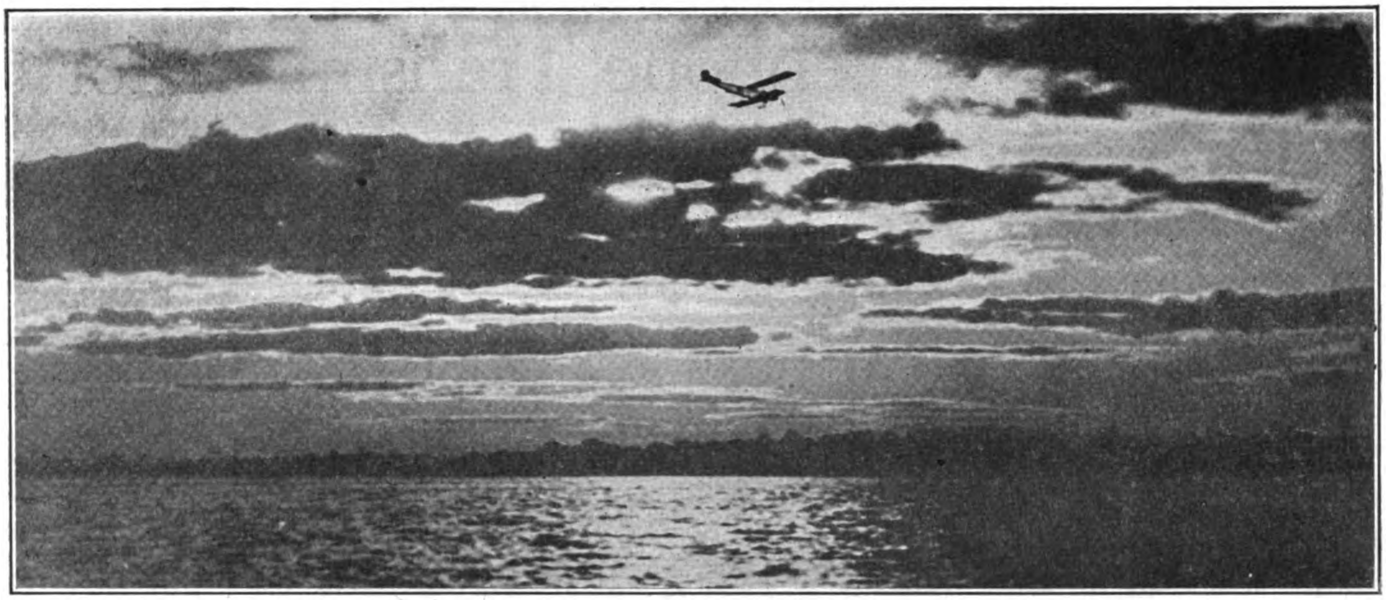
The night was mild and the sea dead calm. I was aft, taking an after supper prom on the poop, when we were startled by a dull "kerump!"—the queer and very distinctive sound an aerial torpedo makes when it explodes. We rushed to the other side of the ship and found the show in progress. Searchlight rays were sweeping back and forth across the skies like blades of grass waving in the breeze. Every few seconds there would be a red flash from the ground and the "kerump" which followed told that another bomb had reached its mark. The Germans were by now over the main section of the city and they began dropping flares. These flares were attached to parachutes and gave a very powerful illumination of 400,000 candlepower held suspended in the air, lighting the ground beneath to a circular area more than a mile in diameter. While the flares made it possible for the Hun fliers to observe the activities on the ground and ascertain the location of the important buildings, they also made it more difficult for the anti-aircraft gunners to locate them, as they flew above the



As evening approached we observed planes going off toward the front lines

lighted area. A barrage was put up all about the city by having the anti-aircraft guns fire shells into the air which were timed to burst at various heights. Each line of guns having a shell bursting at a greater height than the other before it, the air became filled with bursting shrapnel, thus forcing the Boche machines to a greater height than was favorable for their operations.

Anyone who has ever heard a German airplane motor will be sure to remember its queer tone. It has a regular beat or throb to it instead of the purr that the allied engines have. A Canadian lieutenant at Dunkerque had told me how these Hun machines sounded and I recognized the tone immediately. Louder and louder came the "hum-ahum-ahum" till it was directly over our heads. All the lights aboard were out; we stood there in the darkness and gazed up and cursed. It is almost impossible to express the baffled feeling of rage when you are placed in a position where the enemy can fire on you and



Lights sprung up in the landing fields and the planes which had gone forth to give battle to the raiders came down

you can't fire back. It would have relieved the tension if we could have fired our machine gun, but unfortunately this had been stowed away on our arrival at Dunkerque.

Suddenly, the monitors to our port side began firing their anti-aircraft batteries. The shrapnel exploded with piercing crashes overhead and we ducked for cover to be out of the way of falling pieces, for the scattering fire is almost as dangerous coming down as it is going up. As we stood by, helpless and watching, I became conscious of a succession of sounds that had hitherto been meaningless. Then I realized that all during the noise, the German wireless station KBU could be plainly heard working by those amidships. The signals were audible fully eight or ten feet away from the radio cabin.

A move was made to launch a boat; then we were told to have it in readiness to lower. Our greatest danger lay from shrapnel or in a spark from a flare setting off the gasoline in our tanks. The captain appreciated this a moment later and ordered the boat back into the chocks, accompanying the order with the assurance that should the ship explode we'd need no boat to carry us into a different vicinity.

We were held in suspense through many minutes, each of which seemed hours long. The Germans swept across the city three or four times; then they passed on down the coast to Calais where they also gave a short performance, and returned to us. Machine guns and anti-aircrafts reopened fire, evidently without success. But a red glow had broken out over the northern section of the city, indicating that some of the bombs had taken effect.

After another hour or so the firing gradually ceased and the allied air scouts signaled with Morse lights that all was clear. Lights sprung up in the landing fields and the planes which had gone to give battle to the raiders came down.

I sat out on deck till near morning. All along the front the artillery was active. We could see the flashes and hear the booming of the big guns "up the line" as they pounded away all night. . . .

The next day the communique read: "All quiet on the western front."

Aircraft Maker to Have Wireless Equipped Automobile

WHEN it comes to the matter of equipment it is probable that Glenn Martin's new car is going to be the most completely equipped automobile that ever turned a wheel. The airplane manufacturer recently visited the Los Angeles Stearns-Knight headquarters and gave an order for a 1919 four-cylinder Stearns to be delivered to him at his Cleveland plant.

"It's going to have practically everything that an airplane has on it, including a combination wireless telephone and telegraph outfit," Martin said. "My work is divided between the flying fields and the factory, so that it is of extreme importance to me to be in touch with both places at all times, and it will be a marked convenience as well to be in communication with the aviators in their testing work in the air.

"At present, these wireless outfits cost $2,200, but I can foresee the time when they will not cost more than $500, and will be installed as optional equipment on many high-grade cars. They have a telephonic range of thirty miles, and the simple turning of a switch converts them into a wireless telegraph outfit with a range of 300 miles.

"A red light will flash on the dash of my car when someone wants to get in communication with me, and it will only be necessary to put the receiver to my ear to get the message, if I am within thirty miles of the man who wants to talk to me.

Wireless Telephone Transmitter for Seaplanes

Flying Boat Type S. E. 1100, Developed by the American Marconi Company for Navy Use During the War

MARKED progress in the perfection of airplane wireless telegraph and telephone apparatus is a direct result of exhaustive researches in radio communication which have been conducted during the past two years. Light-weight transmitters having a sending range of 150 miles or more have been developed. Spark apparatus has been employed to a considerable extent in airplane communication, but transmitters utilizing the vacuum tube oscillator have the advantage of permitting either speech transmission or telegraphic signals by damped or undamped oscillations, at the will of the operator.

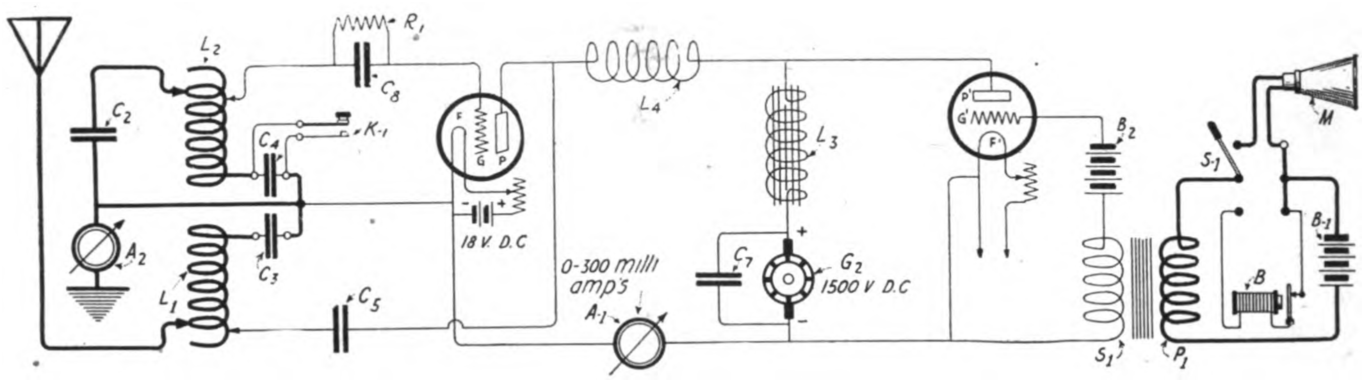


Figure 1—Fundamental circuits of the wireless telephone transmitter for seaplanes

Practical wireless telephone apparatus of the vacuum tube type is disclosed in the following description of the Marconi type S.E. 1100 set—a comparatively high power bulb transmitter—developed by the Marconi Wireless Telegraph Company of America.

The set was designed primarily for the large flying boats, the H-16 class, of the U. S. Navy, and has fully satisfied every test to which it has been put. In one of the earlier tests in flight over Chesapeake Bay, telegraph signals radiated from a trailing antenna on an H-16 boat were heard distinctly in Washington, D. C., over a distance of 120 nautical miles. Subsequent tests with the set used as a wireless telephone permitted the accurate transmission of speech over a distance of 150 miles. The transmitter radiates at two wave lengths, 1600 and 600 meters. For the former wave length a trailing wire antenna of .0004 mfd. is employed; for the latter, an emergency aerial of .00026 mfd.

The transmitter is supplied with two 3-electrode tubes of the pliotron type. One tube is employed as an oscillator for the production of radio frequency currents and the other as a modulator and amplifier of the voice currents communicated to it by the microphone.

The fundamental circuits of the set are shown in figure 1, the actual circuit in figure 2, a front view of the transmitter in figure 3, a rear view in figure 4, a side view in figure 5 and a wiring diagram showing the function of the change-over switches in figure 6. An installation sketch is shown in figure 7.

Description of the Circuits

For best understanding of the operation of the apparatus, it should first be appreciated that if the grid and plate circuits of a vacuum tube include radio frequency circuits coupled inductively, conductively or electrostatically, alternating currents of any desired frequency may be generated. This is the first requisite;

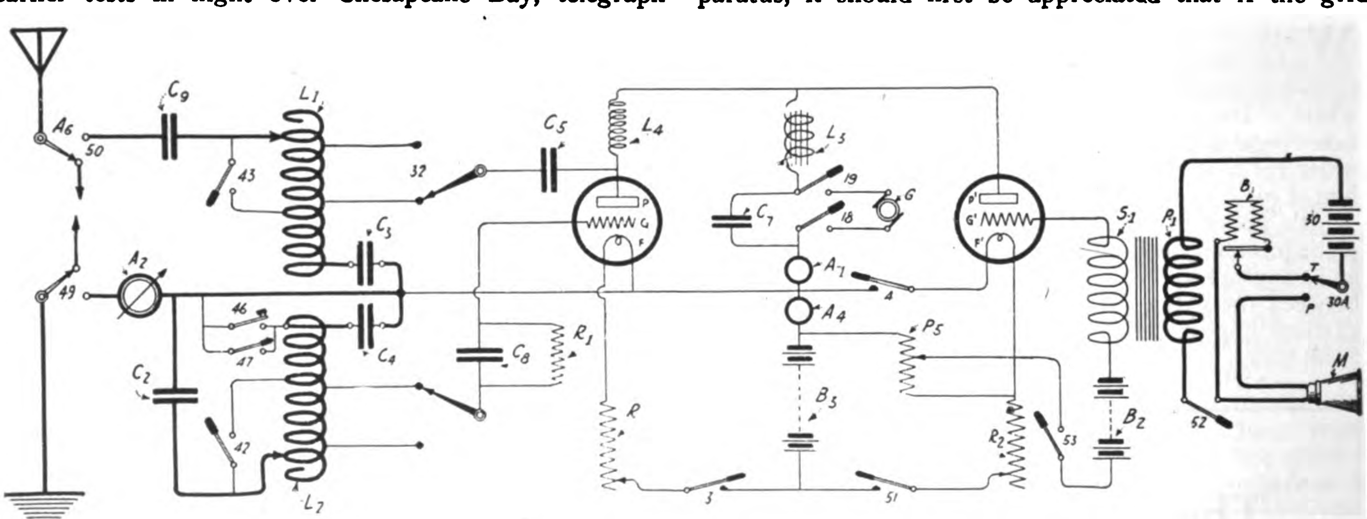


Figure 2—The actual circuit used in practice

other problems, such as rapid change of wave length, satisfactory modulation, and the elimination of disturbing capacities between circuits, arise in the practical set, and are of equal importance. They were satisfactorily solved only after diligent research.

In order to set valve circuits into a state of radio frequency oscillation, it is necessary that the connections be so made that the grid end of the grid inductance will be alternately negative and positive as the plate end of the plate inductance is positive and negative. When the grid and plate radio frequency circuits are coupled with the proper phase relation, any variation of voltage in either the grid or plate circuits will cause minute disturbances in the oscillation circuits, setting them into oscillation at whatever frequency they happen to be adjusted to. For example, a slight variation of voltage in the plate circuit by any means whatsoever, will cause its resonant circuit to oscillate at radio frequency, and the resultant currents will act upon the grid circuit, setting it into oscillation at the same frequency. The resulting radio frequency fluctuations of the grid potential will act upon the plate at the right time to keep the plate resonance circuit in a state of oscillation, and this state of affairs will continue so long as the proper supply of voltage and filament current is maintained, but not otherwise.

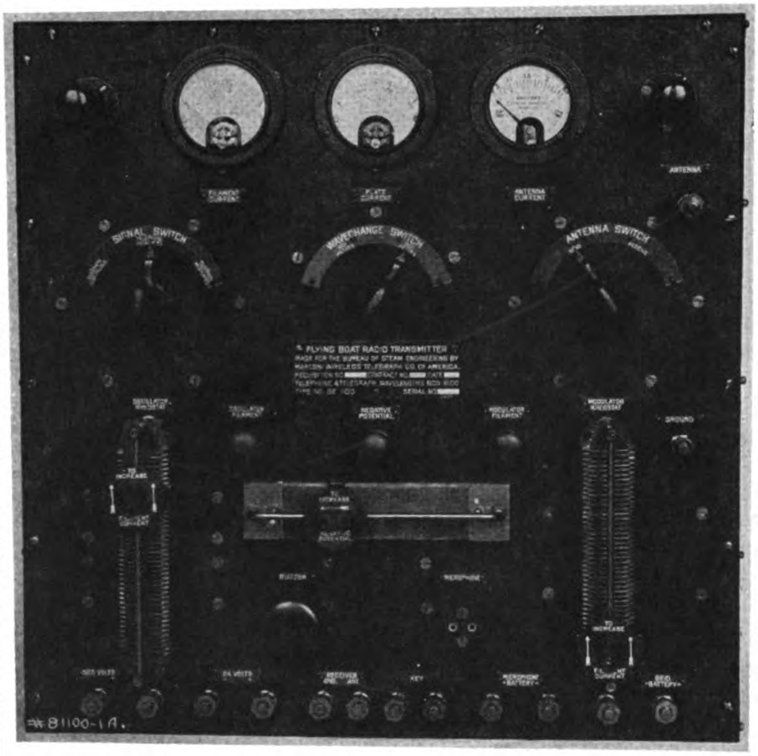


Figure 3—Front view of the Marconi wireless set, SE1100, used in flying boats

The tube is able to generate alternating currents because of its amplifying properties. The energy delivered to the grid circuit in accordance with the actions just outlined will gradually increase in value until a maximum is reached, which is the maximum output the valve is capable of delivering, as may be discerned from the well-known characteristic curve.

Referring to figure 1, it will be observed that the plate and grid circuits of the tube contain the coils L-1 and L-2, in inductive relation, each connected through the condensers C-3 and C-4 to the negative side of the filament. The grid oscillating circuit comprises the coil L-2, the condenser C-2 and a protective condenser C-4. The plate oscillating circuit includes the condenser C-3, a part of the coil L-1 and the series condenser C-5. The antenna and earth connections tapped off from the coil L-1 take the place of the condenser C-2 in the grid oscillating circuit. C-2 is called the balancing condenser. In series with the grid is another condenser C-8 shunted by a leak resistance R-1, which maintains the grid at a negative potential.

The system further includes a three electrode tube F′, G′, P′ which amplifies the output of the microphone circuit and simultaneously modulates the output currents of the oscillating bulb.

It will be noted that the plate circuit is fed by a 1500 volt DC generator G-2, the positive terminal of which connects to the plate P of the oscillating tube through the audio frequency inductance or transformer L-3 and the radio frequency inductance L-4. The negative side of the generator connects through the milli-ammeter A-1 to the negative side of the filament F. The condenser C-5 is the protective condenser which is generally employed in tube oscillating circuits when the source to the plate circuit is connected in shunt to the plate and to the filament, as is the case in this circuit. The modulating circuit shown to the right of the drawing permits either voice transmission or telegraphy by damped oscillations.

CIRCUITS FOR WIRELESS TELEPHONY

For telephony, the microphone M is placed in series with the telephone induction coil P-1, S-1, and the battery B-1, by means of the switch S-1. The coil S-1 is connected to the grid and filament of the modulating tube, and includes in its circuit the battery B-2 through which the grid is held at a suitable negative potential for maximum magnification. The filament and plate of the modulating tube are shunted across the plate circuit of the oscillating tube. The audio frequency choke L-1 may be said to act as a one to one transformer. The radio frequency choke L-4 prevents the radio frequency currents developed by the oscillator from flowing back to the plate circuit generator G. C-7 is a protective condenser for the plate circuit generator.

When the transmitter M is spoken into, speech currents of variable frequencies generated by the microphone are impressed upon the grid circuit of the modulating tube and, through the medium of the auto transformer L-3, alternating currents are superposed upon the plate circuit of the oscillator. This in turn varies the amplitude of the oscillator currents at speech frequencies, and accordingly the amplitude of the radio frequency oscillations flowing in the antenna circuit. It is essential that the key K-1 of figure 1 be closed for the production of undamped oscillations, for when it is open the tube stops oscillating. Manipulation of this key permits telegraphic signaling by the undamped oscillations produced by the tube.

TELEGRAPHY BY DAMPED OSCILLATIONS

When it is desired to telegraph by damped oscillations, the change over switch S-1 is thrown from the microphone to the buzzer B which is energized by the battery B-1. The interrupted currents fed by the buzzer through the primary P-1 of the induction coil produce alternating currents of higher voltages in the coil S-1, which in turn are magnified by the modulating tube, the latter varying the radio frequency currents in the oscillator tube at the frequency of the buzzer. In this way, the antenna radiates *damped oscillations* in groups, the frequency of the groups varying as the number of interruptions of the buzzer.

A more detailed circuit of the Marconi aircraft set appears in figure 2. This diagram not only embraces the fundamental connections of figure 1, but includes all necessary switches for the three different signaling func-

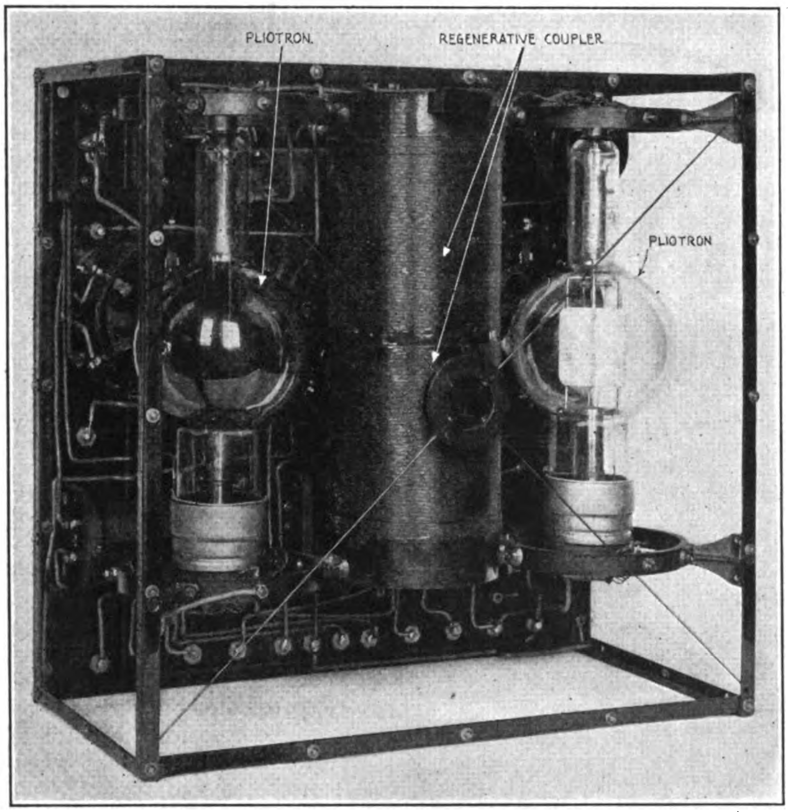


Figure 4—Rear view of the transmitting set with pliotrons in place

tions on the 600 and 1600 meter wave. It includes, moreover, a detailed wiring diagram of the filament circuits.

Details of the Filament Circuit

The filament circuit divides at the positive terminal of the 24 volt storage battery B-3, one branch going through the rheostat R-1 to the filament F of the oscillating valve, and the other going through the rheostat R-2 to the filament F′ of the modulating valve. The negative sides of the two filaments are connected together and to ground. In addition there is provided a potentiometer P-5 connected across the battery B-3 with a tap leading to the negative potential battery B-2 and on through the secondary of the microphone transformer S-1 to the grid G′.

The object of the potentiometer in figure 2 is to compensate for any loss of negative potential in the grid circuit G′, which may be occasioned by the lowering of the voltage of the filament battery B-1.

The switches for shifting the connections from one system of signaling to the other are enclosed in drums, as may be noticed in the left hand part of the photograph of figure 5. The schematic diagram of these is shown in figure 6. The inside and outside rows of jaws on each set are represented by the upper and lower group of dots in figure 6. In that figure the left hand pair constitute the *wave length changing switch,* the middle pair, the *sending and receiving switch* and the right hand pair, the *signal switch.* The first, second and third positions of each switch are indicated by the letters X, Y and Z, these letters being placed between the two points which the blades of the switch short circuit in that position.

Regarding the action of the oscillating valve itself: When the grid is negative in respect to the filament, no current passes between the grid and filament; but when it is positive, considerable current passes which constitutes a loss in the circuit; but if the grid is held at a constant negative potential this energy loss is reduced and a more effective transmitter is obtained. The grid potential may be held at a negative value by the insertion of a grid battery but it can be done in just as effective a way by inserting a condenser in the grid circuit which rectifies the grid currents and holds the grid at a negative potential.

If the leak were not provided, the potential of the grid would rise to such a high negative value that all action would be stopped. A leak of proper value definitely limits the maximum negative potential of the grid and therefore does away with the necessity for a special grid battery.

Change-Over Switches

The numbers on the separate single pole switches in figure 6 correspond with those shown in figure 2. The *outside row* of studs on the wave length changing switch perform the following functions: In the 600 meter position (X at 32 in figure 2) the first tap on the upper section of the loading coil L-1 is connected to the plate series condenser C-5, and at 43 short circuits the end portion of the same coil. In the 1600 meter position Y, it connects at 32 the second tap of the coil to the condenser and opens the short circuit.

The *inside row* of studs on the wave length changing switch performs the same functions for the coil L-2, which is the lower portion of the long single coil mounted in the middle of the rear of the panel in the accompanying photograph. In the schematic diagram, figure 6, the blade marked 35 is shown connecting to the first tap of the lower portion of the coil in the 600 meter position, and to the second tap in the 1600 meter position to the grid condenser C-8 with its leak resistance R-1. The actual wiring of the set differs slightly from this, for it was found that the same tap of the coil was correct for both wave lengths. For this reason, there are but two taps on the lower portion of the coil. The first of these is coupled

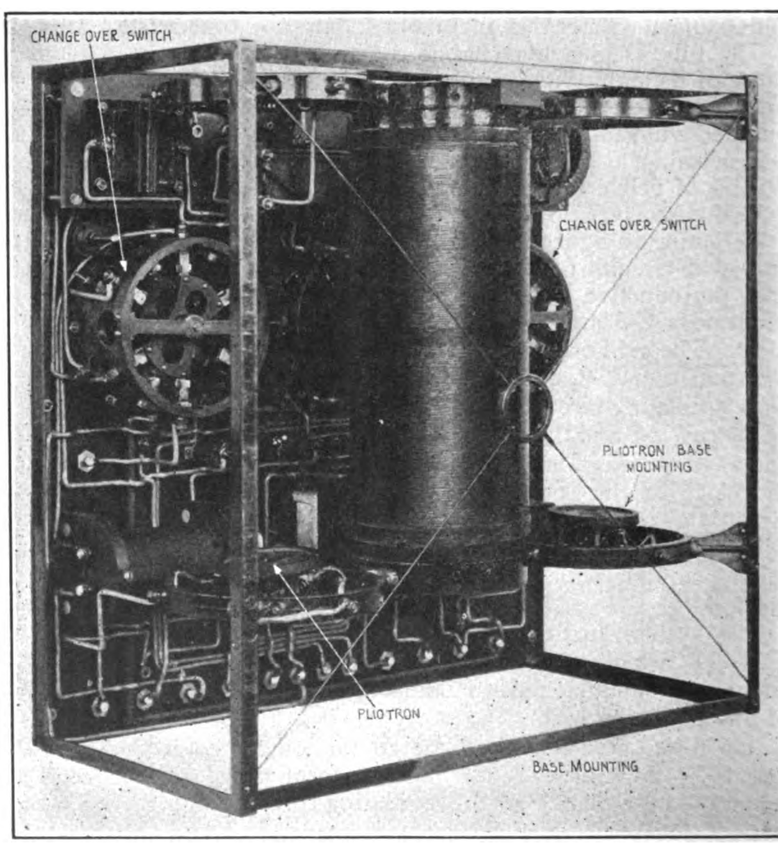


Figure 5—Rear view of Marconi flying boat wireless set with pliotrons removed

directly to the grid condenser C-8 and does not go through the wave length switch. The blade marked 42 short circuits one end of the coil L-2 in the 600 meter position and removes the short circuit in the 1,600 meter position.

The outside portion of the switch marked "send-receive" (in the right hand position of figure 3 and also in the upper central position of figure 6) serves to connect the antenna A-6 to the transmitter in the "send" position (X) and to the receiver in the "receive" position (Y). In the "send" position the circuit of the antenna at 50 is through the series condenser C-9 to the top of the loading coil L-1 and to the ground. The latter is connected at 49 through the antenna ammeter A-2 to the main ground bus of the set which is the frame.

The inside portion of the "send-receive" switch, in the lower part of figure 6, is idle in the receive position Y, but in the "send" position X at 21, it completes the 1500

METERS AND THEIR FUNCTIONS

Space and weight considerations demand the fewest possible measuring instruments. A direct current ammeter A-4 is connected in series with two filaments and reads the total current taken by both of them. The instrument's scale registers from zero to 10 amperes; to read the current in either filament it is merely necessary to cut out the other one. This may be done by means of two small switches marked on the set "oscillator filament" and "modulator filament."

The principal indicator for checking up the proper operating conditions of the set is the plate current drawn by each of the valves from the dynamotor, the voltage of which, as already mentioned, is 1500 volts. This reading is obtained from the plate current ammeter A-1 of figure 2, connected in the ground leg of the supply circuit. This instrument reads from zero to 300 milliamperes and measures the total plate current taken by the oscillator

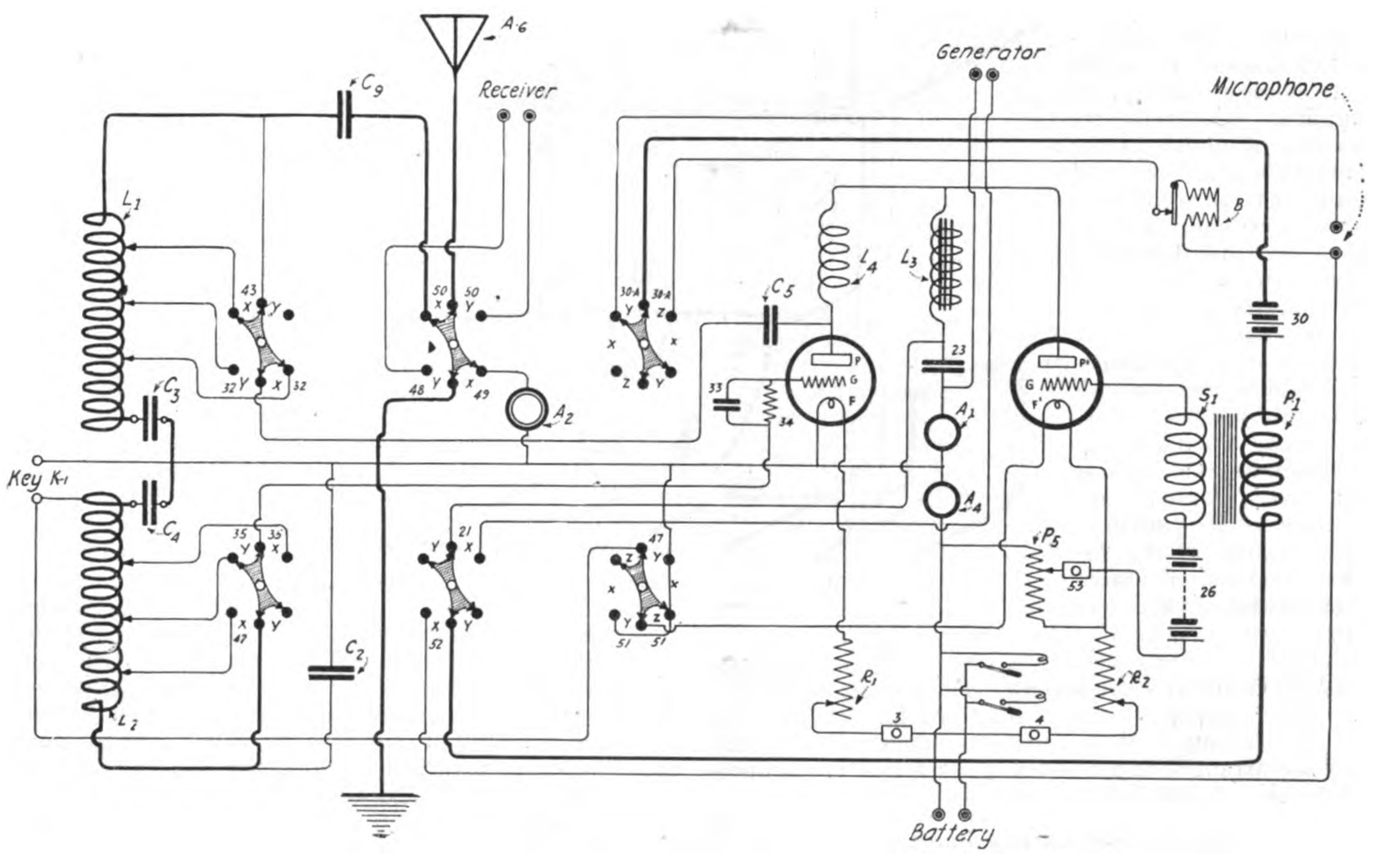


Figure 6—Wiring diagram showing the function of the change-over switches

volt DC supply current to the plates P and P-1 of the pliotrons. At 52 it connects the primary of the microphone transformer P-1 to the microphone terminals 28 and to the buzzer B. These connections are opened in the "receive" position.

There are three positions for the signal switch. The first, X, is for *continuous wave telegraphy*. In this position the connections made in the second and third positions are opened. The second position Y is for telephony; the inside portion of the switch (the upper part in figure 6) connects the microphone to the microphone battery, and at 51 the outside portion (in the lower part of figure 6) completes the filament circuit for the modulating valve and short circuits the key at 47. In the third position, the switch connects at 30 A the buzzer to the microphone battery and at 51 keeps the filament of the modulating valve lighted, removing the short circuit from the key.

The position of the switches in figure 6 does not correspond with their location on the set. All three switches are built to stand a maximum of 10,000 volts high frequency potential, although the potentials developed in the apparatus are considerably lower.

and modulator. The maximum voltage developed by the dynamotor is 1600 volts and the vacuum tube generally will cease to operate when it falls below 1100 volts. The generating tube will oscillate over a wide range of plate voltages if the filament current is kept below a certain critical value. The filaments of the pliotrons are designed to operate on 18 volts.

WIRING

The entire set is wired with No. 12 B & S bare soft copper wire with empire cloth tubing slipped over it as insulation. No terminal lugs are used; the ends of the wires are bent in the shape of an eye which fits the stud terminal and is passed around it in a direction that tends to make the wire grip the stud when the nut is tightened.

The wiring has been so located that small or disturbing capacities between the wires are avoided.

STRUCTURAL CONSIDERATIONS

Owing to the vibration of the airplane every possible precaution has been taken to prevent the fastenings work-

ing loose. Special steel lock washers are used throughout the set. The general scheme of construction is such that the main supports and fastenings will bend before they break, wood or any material which splits or fractures, having been eliminated. The steel wire cross braces shown in the photograph make the structure an extremely light and a surprisingly rigid unit.

Power Supply

The primary source of energy is two 12 volt, 50 ampere hour batteries of the Willard lead type similar to those used in automobile starters. The filaments of the two pliotrons are operated through a rheostat directly from the 24-volt storage battery. Since the tubes require a plate E.M.F. of 1,500 volts DC, a small dynamotor, driven by the 24-volt storage battery, is supplied. The armature has two windings in the same slots, one connected to the 24-volt commutator at one end, and the other to the 1,500-volt commutator at the opposite end. It is a two-pole machine excited from the 24-volt source. The armature, which runs on ball bearings at 5,000 r.p.m. and draws about 30 amperes on its full load at 450 watts, weighs approximately 30 pounds.

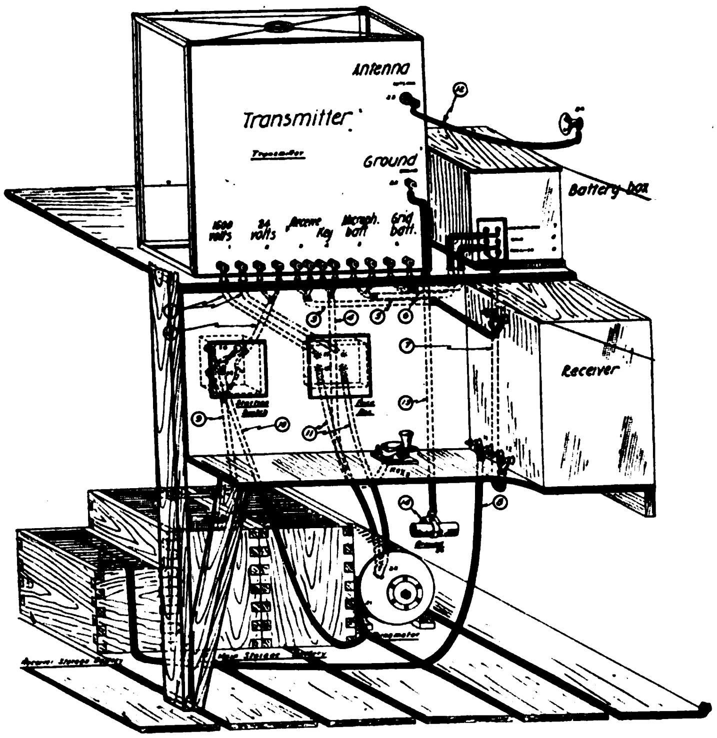


Figure 7—Sketch showing the installation of the complete set

In addition to the 24-volt storage battery, three other batteries are required; two for the transmitter and one for the receiver. These three sets are known as the *microphone battery, grid battery* and *receiver battery*. The voltage of the first is 5; of the second 60, and of the third 40. The 60- and 40-volt sets consist of 20-volt units connected in series. They are arranged in a wooden box screwed to the operating shelf. A dilecto terminal block is supplied.

The Support of the Pliotrons

To insure against breakage, the best position for the pliotrons is vertical with the large neck at the bottom. This brings the *plate terminal cap* at the top and the *filament and grid terminal cap* at the bottom. In each of the two dilecto rings shown at the top of the photograph, three spiral springs placed 120 degrees apart support a spring cap which fits over the plate terminal cap of the pliotrons. The springs are held by small machine screws which pass through the insulating ring. One of these serve as a terminal, being connected by a pig-tail to the spring tap. In each of the two bottom dilecto rings, three spiral springs, placed 120 degrees apart support a special jack block made to take the filament and grid terminals. This block is made in two halves, upper and lower, held together by screws; clamping these spring jacks between them, three posts, which project from the bottom of the jack block, take the ends of the three supporting springs, and are electrically connected by a copper pig-tail to the screw-eyes that hold the other end of the spring to the dilecto ring. The two filament terminals of the tube and the grid terminal are brought out to the three screws in the dilecto ring. Thus, each pliotron is supported to the rigid frame of the set by 6 springs which are set so that when the tube is in place the top springs pull down and the bottom springs pull up.

The mechanical period of vibration of the vacuum tubes in this spring mounting is considerably below that of any vibration that will occur in the seaplane itself. Sudden shocks in any but a horizontal direction are not transmitted through these springs with sufficient violence to injure the tubes.

The positions of all controlling appliances on the main panel board are clearly indicated in the photograph, figure 3. The small sub-panel is mounted immediately to the rear of the frame.

Reel Antenna and Accessories

The antenna reel group for this set consists of the reel mechanism, a removable drum with antenna wire and spare drums with complete antennae on them. The wire from the reel runs through a take-off pulley and passes through the lead-in insulator in the side of the hull of the boat. It then passes through either a strut pulley or wing pulley, depending upon the type of the boat.

Reel Mechanism

A cast aluminum plate, clamped to one of the main struts in the hull of the boat, carries a shaft on which the drum turns. On this same shaft, next to the attachment plate, there is a brake drum of castaluminum, and around this drum a cast iron brake band. The band is sprung over the drum and prevents it from turning except when a cam which is attached to the brake lever springs it open. A pin on the brake drum engages holes in the main drum, when the latter is put on the shaft. The crank by which the main drum is turned has a square hub on which the drum sets. It is slipped onto the shaft, and latches in place. The latch is released by a latch handle just behind the arm of the crank. To remove the drum, to put a new one in place, the operator grasps the arm of the crank, and in so doing also grasps the latch handle and releases the latch. He then pulls the crank and drum off together. One drum may then be slipped off the hub of the crank and a new one put on, and the two slipped back onto the shaft.

Reel Drum and Antenna

The drum is a pressed steel spool, black japanned, and will hold about 600 feet of the standard antenna wire. It has a square hole at its center which fits the hub of the crank. The antenna wire has a ball at the reel end, and this ball is dropped through a hole in the drum face. The other end of the wire is attached to a swivel, and this in turn is attached to the "fish" or weight.

Lead-in Insulator

The lead-in insulator is a moulded "electrose" fitting, with a metal tube running through it, and a wide flare at either end, so that the wire cannot catch on the ends of the tube even if it enters at right angles. The insulator is held by lock-nuts in a hole in the side of the hull. The antenna connection from the set is brought to this insulator. When the antenna is out, the ball on the reel end

of the wire rests against the inside flare of the insulator. The wire is thus entirely disconnected from the reel, and the reel is dead. When it becomes necessary to reel up, the ball is grasped, and of course brings the wire with it. The ball is passed through the take-off pulley and dropped through the hole in the drum face, and the crank is turned. The brake mechanism is arranged so that the cam may be left holding the brake off during the reeling-up process.

Figure 7 shows the position of the receiving storage battery, the main storage battery transmitter, transmitting key, receiver, and battery box.

The maximum antenna current is 2.5 amperes, with the antenna supplied with the set. This has been found to satisfy all ordinary distance requirements.

Comprehensive instructions are supplied with each set, enabling the operator to obtain the best adjustment for the three signaling positions with the greatest ease.

Uni-Directional Transmitting System

UTILIZING loop antennae, C. S. Franklin of the English Marconi Company has devised the one-way transmitting system shown diagrammatically in the accompanying figures 1 and 2.

It is common knowledge that a frame such as a rectangular circuit of wire placed in a vertical plane and in which high frequency alternating currents are induced,

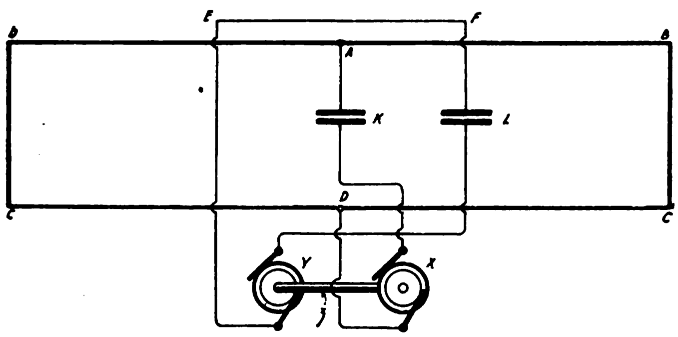


Figure 1—Circuit of the uni-directional transmitting system using two equal frames in parallel

radiates electric waves best in the two directions in the plane of the rectangle, and not at all in the two directions at right angles to this plane. The polar curve of radiation is in fact in the form of the figure 8, consisting of two equal figures which are nearly circles. The waves at any two points equidistant from and one on each side of the rectangle and in its plane are at any instant of time equal and of opposite phase.

As an illustrative example of the working of this system, two equal rectangular or frame circuits may be assumed to be erected in the same vertical plane, either so that they have one vertical edge common to both (in which case they may be considered as being in parallel), or so that they have one vertical edge of one rectangle adjacent to one vertical edge of the other, the two circuits being connected in series so that one is reversed as regards the other. Then if high frequency alternating currents are induced in the two circuits so that the currents traverse them in opposite directions, the combination will as before radiate best in the two directions in the plane of the rectangles, and not at all in the two directions at right angles. The polar curve will again be a figure of 8 made up of two similar figures which are nearly circles. In this case, however, the waves at any two points equidistant from, and one on each side of the rectangles and in their plane, are at any instant of time equal and in phase with each other.

To obtain uni-directional transmission, Mr. Franklin provides a double frame circuit in the same, or substantially the same plane with a simple frame circuit placed symmetrically with respect to the double circuit. The two circuits will have no mutual inductance or coupling effect on one another if they are properly proportioned; that is to say, alternating currents existing in one will not affect alternating currents existing in the other. Under these conditions each circuit tends to produce its own radiation independently of the other circuit.

Before proceeding further with the operating theory, a description of the diagrams will be given.

Figure 1 shows the arrangement of two equal frames in parallel, and figure 2 the arrangement of two frames in series. In figure 1, A,B,C,D, a,b,c,d are two equal rectangular aerials having the vertical side A,D common. In A,D is inserted a tuning condenser K and an oscillation generator X.

E,F,G,H is a simple rectangular aerial having a tuning condenser L and an oscillation generator Y; this aerial is erected in substantially the same plane as the double rectangular aerial and symmetrically with respect to it, so that there is no coupling between the two systems. The two oscillation generators Y and X produce oscillations of the same frequency. It is obvious that the phase of the currents in the two alternators may be varied as desired by changing their relative positions on the common driving shaft z. However, any suitable or known means may be used for producing a desired phase difference. In figure 2, A,B,C,D, a,b,c,d are two equal frames connected in series as shown.

In one direction in the plane of the system of either arrangement (provided that the relative phase of the currents in the two circuits is correct) the magnetic fields from the independent circuits are in phase and produce

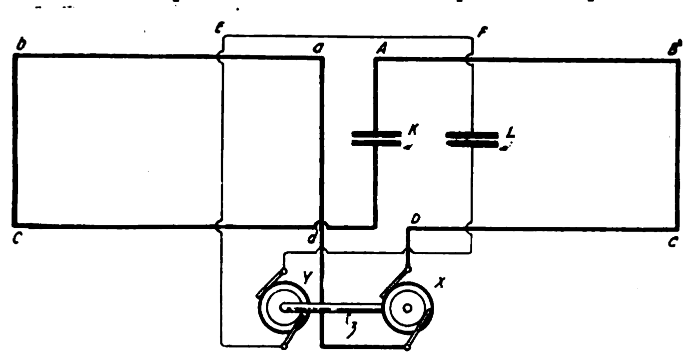


Figure 2—Circuit using two frames in series

a wave with an energy proportional to the square of their sum; while in the other direction the magnetic fields are of opposite phase and produce a wave having an energy proportional to the square of their difference.

Therefore, if the currents in the two independent circuits are so adjusted that they produce waves of equal strength, the magnetic fields in one direction in their plane will produce a wave with four times the energy of the waves from either circuit separately; in the opposite direction the magnetic fields neutralize each other and no waves are produced. In order that the fields may correctly cancel on the one side, it is necessary that the two sets of oscillations have a phase difference of 90°.

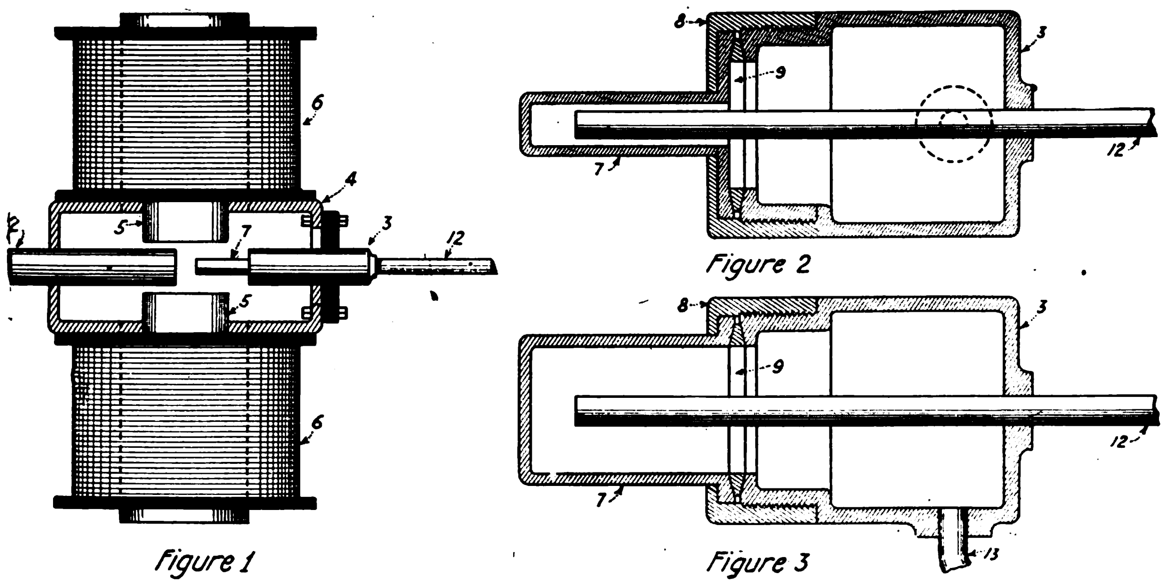
In the two directions at right angles to the plane of the circuits no waves are produced. The result is that practically all the energy is radiated only on one side of the plane, through the system at right angles to its

plane. On that side the polar curves of the two frames add; on the other side of the line the two curves practically neutralize each other.

In practice it is necessary to introduce condensers into the circuits which need not necessarily be rectangles, so as to tune them to the frequency employed. To obtain the best directional effects the circuits should be entirely insulated from the earth, but good directional effects may be obtained if the earth be used as part of one or both circuits.

Fuller's Arc Generator

IN the accompanying diagrams, figures 1, 2 and 3, Leonard Fuller discloses the construction of an arc gap applicable to radio telegraphy. Figure 1 is a horizontal section of the generator; figure 2 is a horizontal longitudinal section of the anode; and figure 3 a vertical longitudinal section of the anode. The carbon cathode 2 and the anode 3 are enclosed in a casing 4 so that the arc between the electrodes may be subjected to a hydrogen atmosphere. When the generator is connected in a wireless transmission system the cathode is connected to earth and the anode to the antenna. Powerful magnets are mounted at right angles to the arc to increase the efficiency of conversion. A very small potential difference exists between the magnet poles and cathode, but between the anode and the poles the potential difference is relatively high and, accordingly, in the ordinary construction there must be greater spacing at this point than between the cathode and the poles.



Drawings showing detailed construction of Fuller's arc generator for use in radio telegraphy

It is desirable for maximum flux density that the air gap between the poles be small. This gap cannot be small on account of the potential difference mentioned, unless the construction is in accordance with the drawings. Arranged on opposite sides of the casing, and having their poles 5 extending into the chamber thereby formed, are the electromagnets 6. The anode 3 is provided with a tip 7 of much less width than the cathode, so as to give the requisite spacing between the anode and poles. The anode is a hollow metallic body and the tip is made of copper, which is hollow and is of rectangular cross section. The tip is secured to the anode body by a screw cap 8, the joint between the tip and the body being sealed by a metallic gasket 9.

During the operation of the generator, the temperature of the anode becomes excessive and would rapidly fuse if it were not for a stream of water which is introduced into the anode through the conduit 12.

Undamped Wave Detectors

W. SCHLOEMILCH of Berlin has recently been acknowledged the inventor of several forms of the sliding wire ticker, a device which has been used experimentally and commercially for a number of years.

Three different embodiments of the device are shown in figures 1, 2 and 3. Figures 4 and 5 indicate the connections of these detectors in receiving circuits and figures 6, 7 and 8 are a front elevation, side elevation and top plan view, respectively, of a constructional form of the ticker. In figure 1, the silver or gold wire electrodes A and B are in contact, the resistance being changed by the vibrations of the buzzer 15 operated by the battery 16. In the particular construction shown in figure 2, the sliding contact is formed by two springs A-1 and A-2 pressing on an endless wire B-1, which is rotated by the wheels or rollers C and E. In figure 3, the stationary contact piece is an adjustable spring A-3, and the movable contact a revolving disc B-2 which can be driven by a motor.

In figure 4, the wave detector A is connected in series with an oscillatory circuit such as the secondary of the receiving transformer, choke coils G and H being provided to prevent the passage of high frequency oscillations through the telephone. In figure 5, the sliding contact detector A, B is located in an aperiodic circuit K which is coupled to the oscillation circuit I.

In the drawings, figures 6 to 8, the detector comprises the disc 1 provided with vanes which are rotated rapidly by clock-work contained in the casing 12. The point of the fine upwardly bent platinum wire 3, bears against the under side of the disc 1. To obtain maximum signals,

the inventor provides a vertical adjustment and the regular adjustment of the sliding point. For the vertical adjustment, the platinum wire is attached to the bushing 4, which can be rotated about a horizontal axis by a handle 5. This bushing is attached to two iron levers 6 which can be rocked about a horizontal axis 8 by means of an adjusting screw 7. The first device permits rough adjustments, and the second, fine adjustments. The entire pressure adjustment is rotatable about a vertical axle 9 so that platinum wire can be adjusted radially relatively to the axis of the disc 1. The relative speed between the wire and the disc may therefore be varied at will.

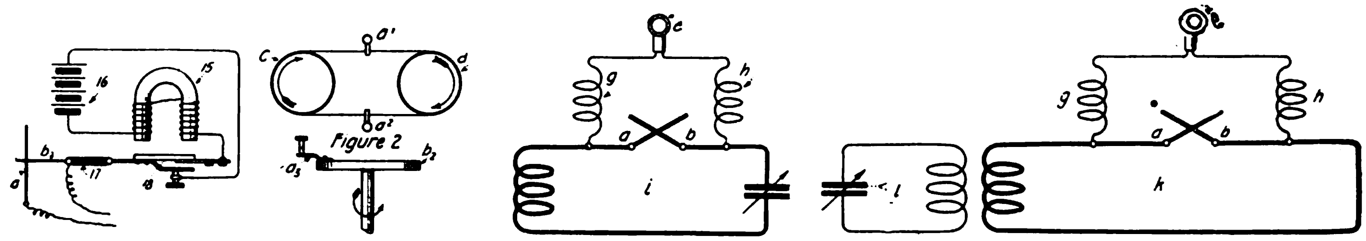


Figure 1 Figure 3 Figure 4 Figure 5

Diagrams showing three forms of the sliding wire ticker and two types of connections

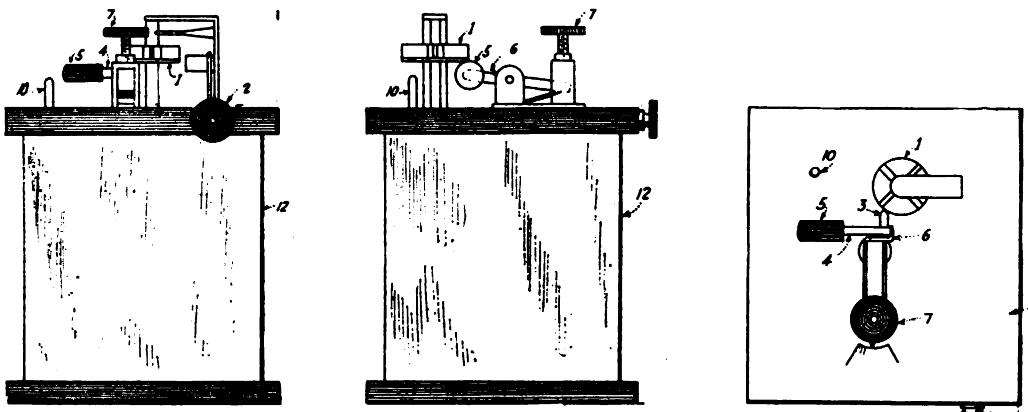


Figure 6 Figure 7 Figure 8

Diagrams showing in numerical order, the front view, side view, and top plan view, respectively, of a constructional form of the ticker

White's Automatic Radio Telephone System

IT is customary in some radio telephone systems to provide an electromagnetically operated change-over switch to alternately connect the transmitter and receiver to the wireless aerial. This is not always a convenient procedure unless the apparatus is operated by one skilled in its use; for a condition is apt to arise where both parties place their apparatus in a transmitting position, and endeavor to talk to each other simultaneously.

To overcome this objection, William C. White has devised the method of automatically changing from a trans-

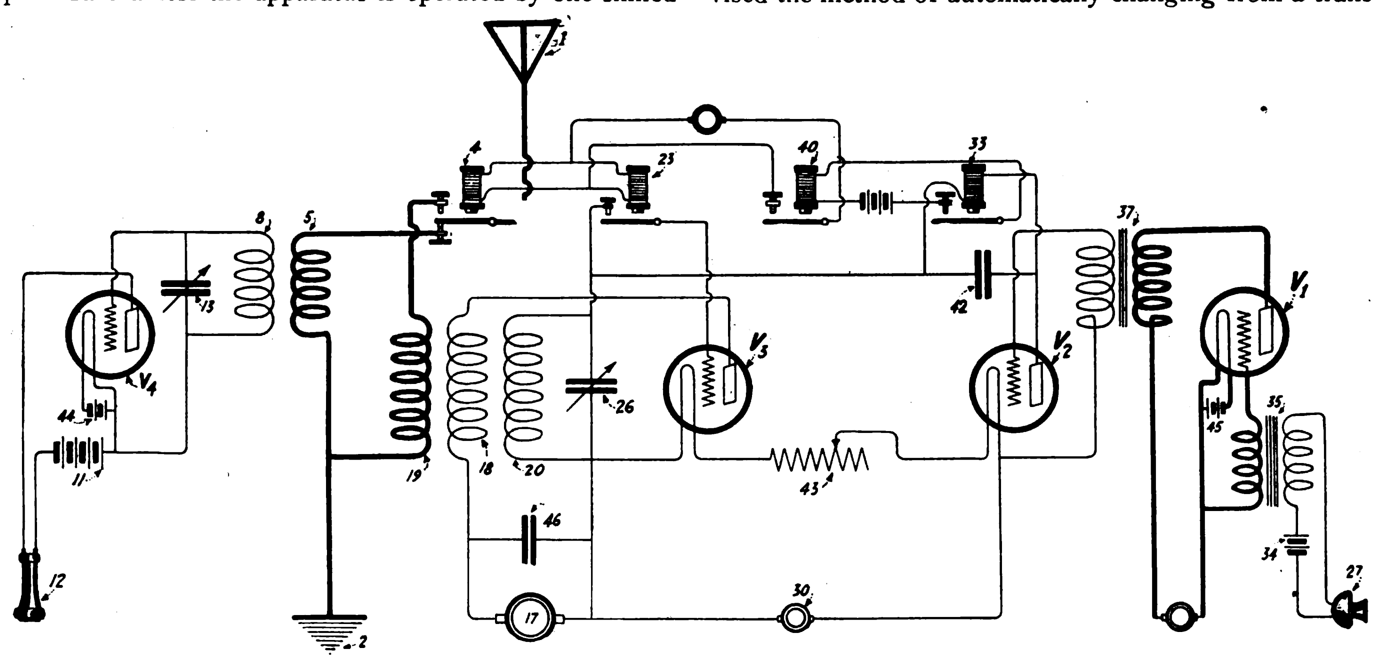


Figure 1—Diagram of White's automatic radio telephone system

mitting to a receiving position shown in the accompanying diagram figure 1, which embraces the complete circuits of a wireless telephone system. In the diagram, the three-electrode tube V-1 amplifies the speech frequency currents generated by the microphone 27. The output circuit of V-1 is coupled to the input circuit of V-2, which is the modulator bulb. The modulator in turn varies the output of the oscillating bulb V-3, which is coupled to generate radio frequency currents at any desired frequency. V-4 is the detecting tube with the usual controlling appliances, including the receiving transformer, 5, 8 and the telephone 12.

A condenser 42 in the plate circuit of the bulb V-2 is shunted by a magnet 33 which opens and closes the relay contacts shown directly underneath. The closing of these contacts energizes the magnet 40, which in turn closes the circuit to the magnets 23 and 24. When relay 4 operates, it breaks contact at 3 and makes a second contact at 25, thus connecting the coil 19 between the antenna and ground and disconnecting the receiving apparatus from the antenna. The relay 23 operates the contact 22 which, when open, prevents the bulb V-3 from generating radio frequency oscillations. When the microphone 27 is spoken into, the transmitter is automatically connected to the antenna as will now be explained.

When the transmitting apparatus is not in operation, the current which flows through the relay winding is not sufficient to operate it, but when the microphone is spoken into the currents thus produced flow through the transformer 37 and reproduce, in the plate circuit of the controlling bulb V-2, variations at speech frequencies, the average value of which will be much greater than the normal current in the plate circuit and will be sufficient to operate relay 33 which in turn operates the other relays previously mentioned. Relays 33 and 40 should be quick acting, and relays 4 and 23 should be quick to close, but should have an appreciable time lag in opening to prevent the transmitting apparatus from being disconnected during a momentary cessation of the sound waves acting upon transmitter 27. The time lag is preferably greater for relay 4 than for relay 23, in order that relay 23 may open and thus stop production of the oscillations before the antenna circuit is broken at 25.

Bellini's Electrostatically Coupled Goniometer

THE Marconi-Bellini-Tosi radio goniometer has been employed in wireless telegraphy for many years. As many of our readers know, the two loop antennae in this device are magnetically coupled through two primaries to a rotating coil which may be revolved on its axis in the resulting magnetic field.

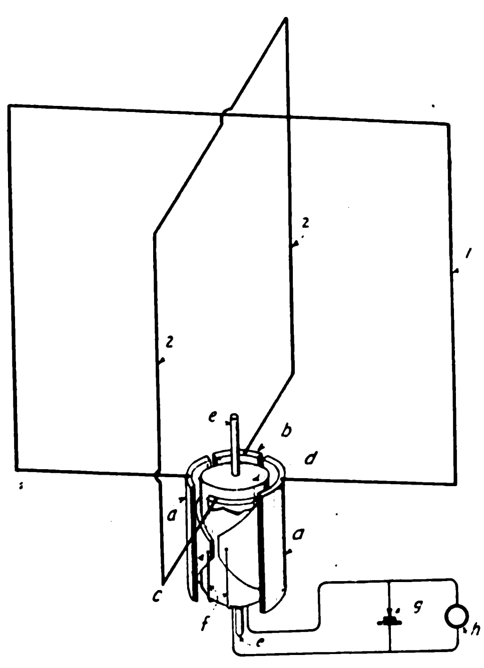


Figure 1—Diagram showing the connections of a goniometer, receiving detector and head telephones

Ettore Bellini, who is a pioneer in directive radio telegraphy, has recently described the capacitively coupled goniometer shown in figure 1. Here two loop antennae 1 and 2 are connected to pairs of stationary plates aa and bb arranged around an axis. On the shaft e is mounted a drum d, upon which are placed the conducting elements c. It is preferable that the conductors have the form shown in figure 2, which when extended in a plane, has the outline formed by two sinusoidal curves, or by the portion of the enclosed surface situated above the axis of the abscissae, s, t. The two plates c (of figure 1 or figure 3) must not touch each other, but must be very close together. The action of the stationary plates is apparently to set up a resultant electrostatic field, the direction of which in the goniometer varies as the direction of the advancing wave. By rotating the inner drum, it may be placed in a position to receive the maximum induction from the stationary plates.

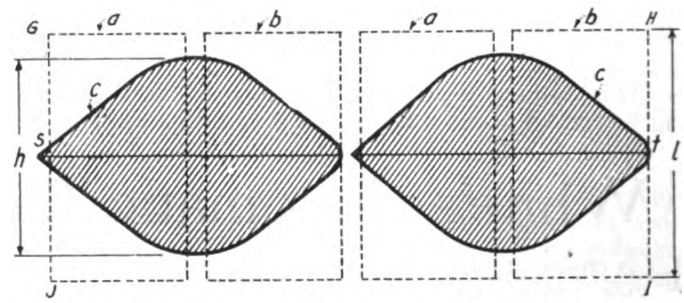


Figure 2—Improved type of conductors

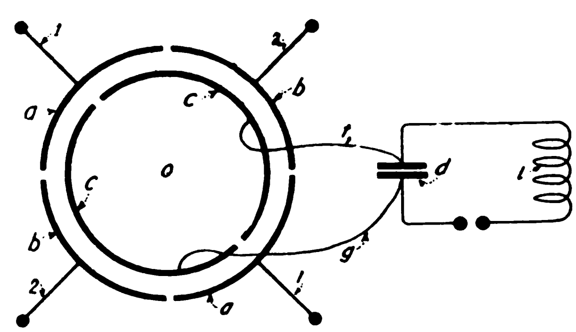


Figure 3—Circuits for directive transmission

The diagram figure 1 shows the connections of a receiving detector g with head telephones h in shunt. Figure 3 shows the circuits for directive transmission, the rotating plates cc being connected to a circuit comprising the condenser d, inductance i and the spark gap. In this diagram 1, 1 and 2, 2 are the terminals of the two loop

antennae. The rotating element therefore serves to impress high frequency currents from a local generator upon

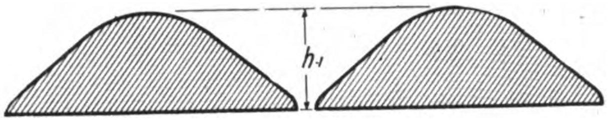


Figure 4—Another form of the improved conductor

the antenna circuit, and to receive radio frequency currents sent out by the distant transmitter.

Figure 4 shows another type of movable plates which can be used in place of those shown in figure 2. Bellini states that, as with the well-known magnetically coupled goniometer, this system can be employed for directive transmission or reception.

Aviators' Intercommunicating Telephone System

G. M. JENKINS, realizing the difficulty of a pilot and observer in an airplane talking to each other on account of the whir of the propeller, the rush of air and the exhaust of the motor, has devised a telephone system including a transmitter and receiver which are strapped to the aviator's head. Moreover, he has provided a switching arrangement so that when the talker puts his head forward to speak a switch is closed, connecting the transmitter into the circuit. This automatic feature is of considerable value, for it leaves the pilot's hands free

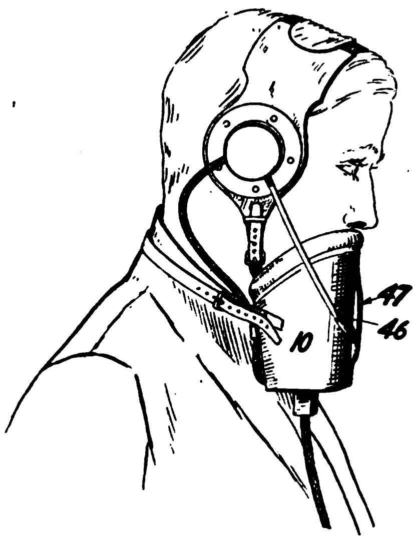


Figure 1

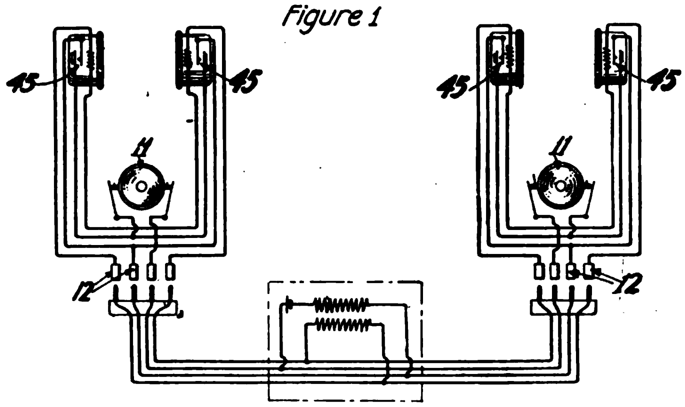


Figure 2

Transmitter and receiver adjusted to operator and diagram of circuit employed

for manipulating his control levers and prevents a drain on the transmitter battery during the period when no conversations are taking place.

Figure 1 shows the transmitter and receiver in position for operation; figure 2 is a diagram of the circuits employed; figure 3 is a front elevation of the transmitter box, a portion of which is cut away to show the mounting in the transmitter. Figure 4 is a side elevation and figure 5 a plan view of the transmitter box in figure 3. Figures 6 and 7 show a head band for holding the receivers, one receiver being shown in position and a portion cut away to show the operation of the transmitter switch.

Each pilot or observer is provided with a transmitter box 10 of leather, adapted for the mounting of the transmitter 11, and a set of four line terminals or jacks 12. The upper portion of the box 10 is provided with a cushion consisting of a soft rubber tube 13 and a soft leather casing 14.

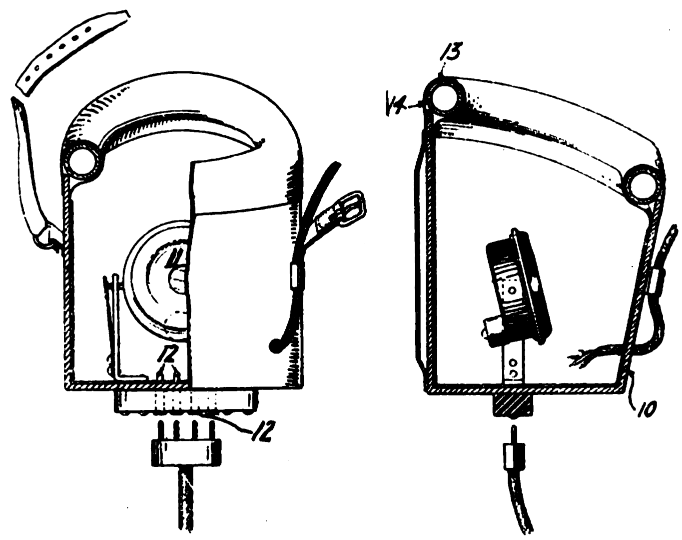


Figure 3 Figure 4

A front and side elevation of the transmitter

On each receiver is a transmitter switch 45 arranged for connecting the transmitter in a circuit automatically when the user lowers his head to transmit. The switch is operated by a wire 46 which extends in a loop from the two head receivers and passes under a strap 47 on the front of the transmitter box 10.

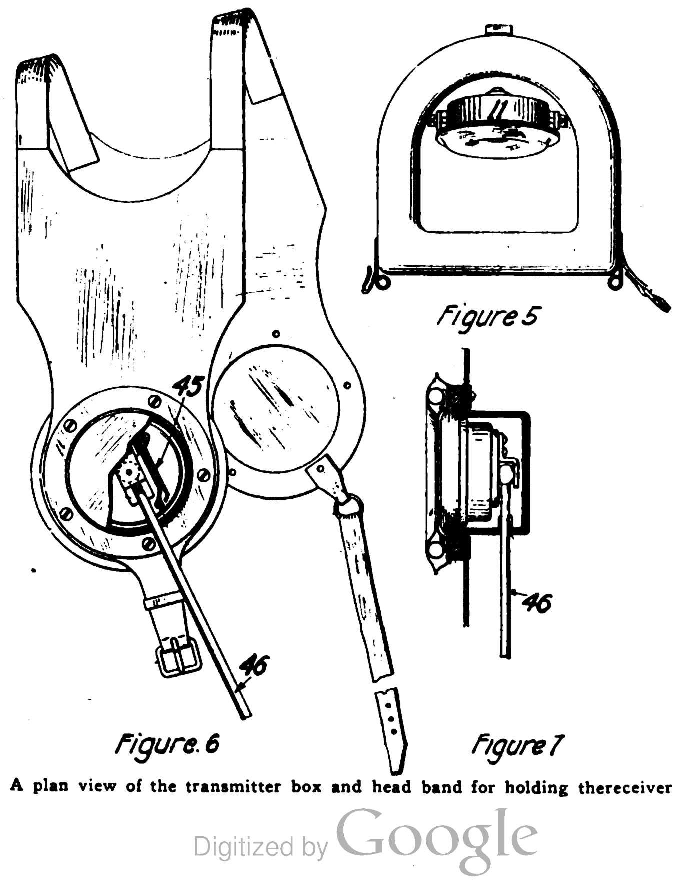
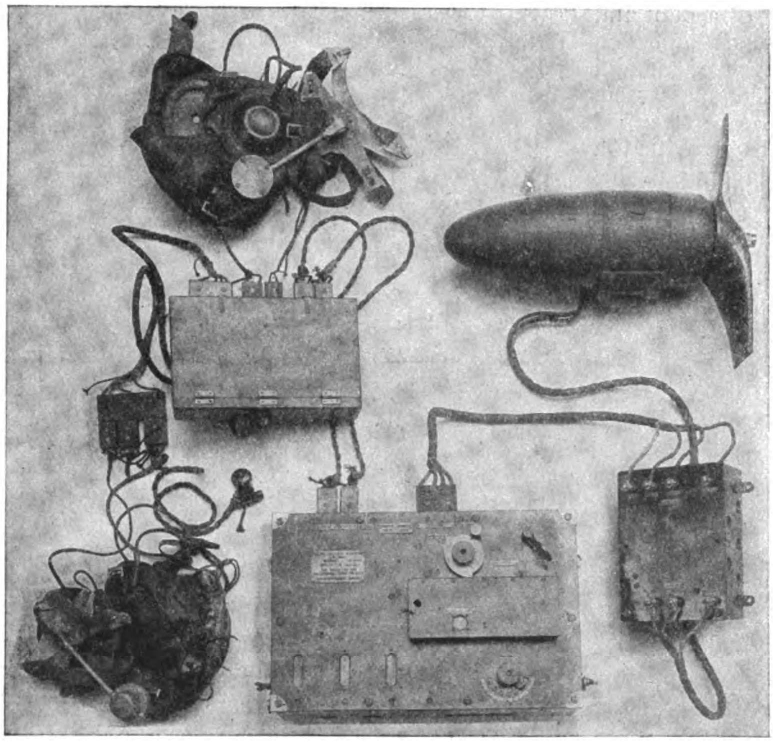


Figure 5

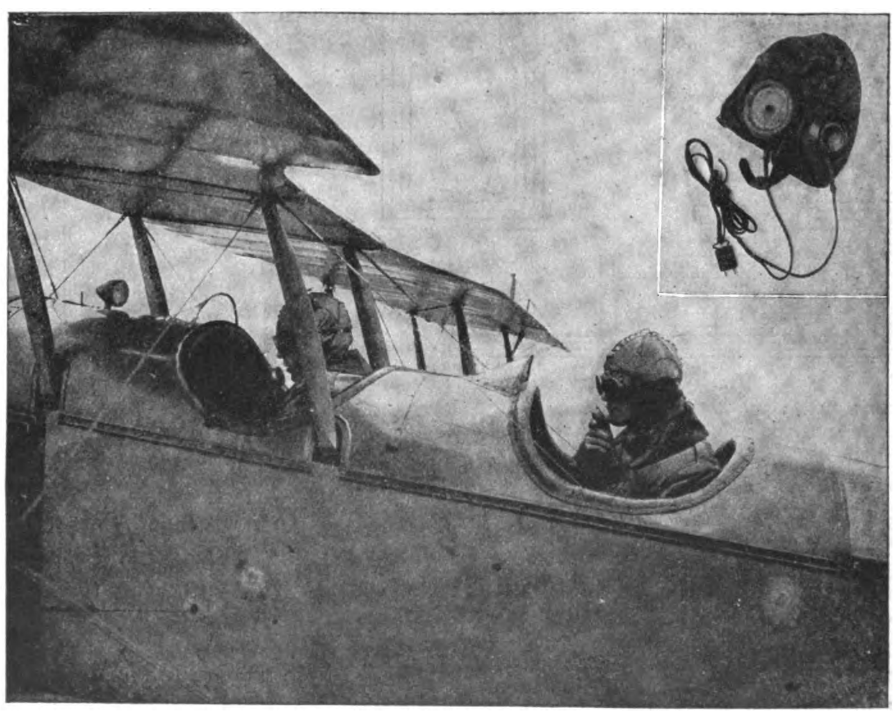
Figure 6 Figure 7

A plan view of the transmitter box and head band for holding thereceiver

Army Airplane Apparatus

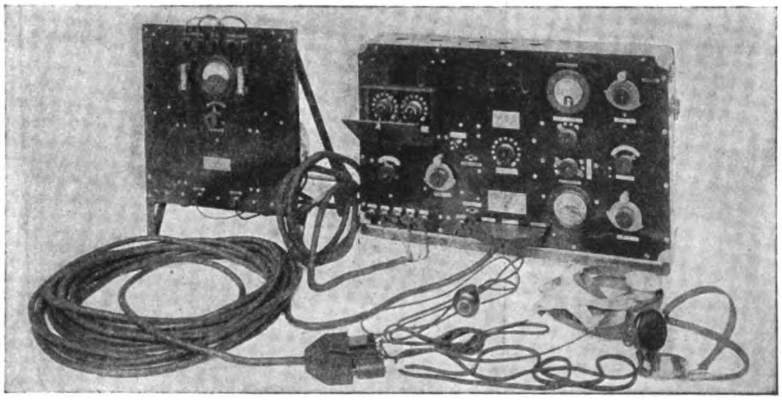


Complete airplane radio telephone set developed for the U. S. Army during the war. This set, known as SCR-68 occupies only one cubic foot of space and weighs 45 pounds. The transmitting circuit includes the antenna capacity as part of the tuned circuit in which a vacuum tube maintains high frequency oscillations, the magnitude of these being controlled by a second tube, which in turn is controlled by the voice currents from the transmitter. The receiving set employs a tuned circuit and a vacuum tube detector, the speech output of which is amplified by two vacuum tubes



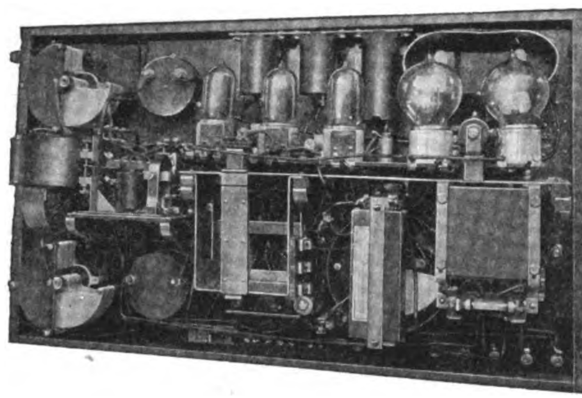
The inset shows the specially designed helmet by which the noise and wind encountered while in flight are overcome and conversation is made possible. In the practical use of the set the observer uses the same telephone equipment for radio and for communication with the pilot

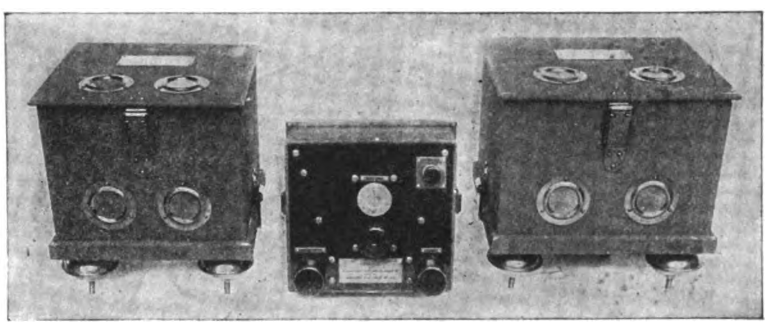
Ground and Short Wave Sets



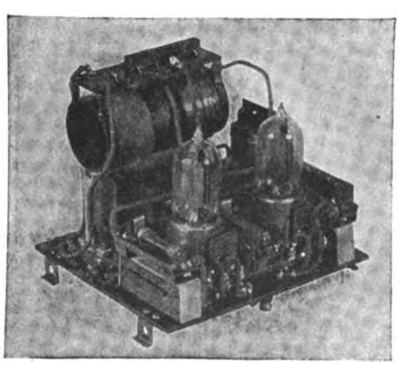
For use on the ground, in talking to observers in airplanes, the U. S. Army used the set illustrated on the left. It is known as type SCR-67 and is similar in principle to the aircraft equipment, but as space and weight are not so restricted, this outfit is designed with a doubly tuned receiving circuit so greater selectivity may be obtained

On the right is an interior view of the ground radio 'phone set illustrated above. A single tuned circuit permits a "stand-by" adjustment for detecting speech, which is transmitted by modulating any one of a wide range of high frequencies. The operator may then quickly adjust for the selective reception of the desired conversation. This equipment also functions under remote control, so that the speaker may make observations of the planes with which he is communicating by standing in the open while the set with which he is connected is protected under cover

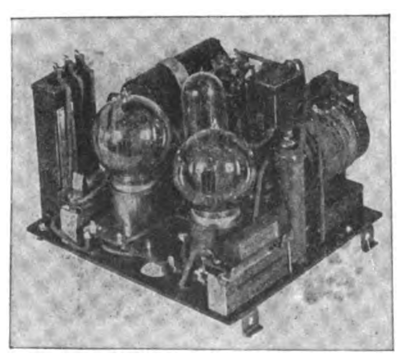




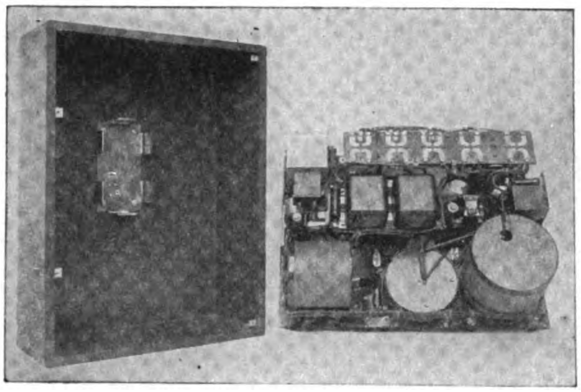
The complete SCR-91 short wave set designed to eliminate the long trailing wire antenna. Its range is from 86 to 116 meters. In the center is a control panel which is mounted before the pilot in the cockpit operating a special set of amplifiers

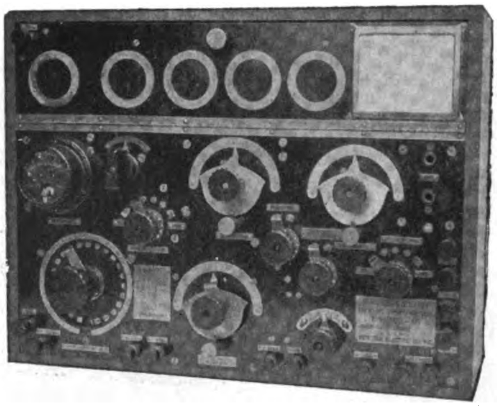


To the right is an interior view of the transmitter, and to the left an interior view of the receiver of the complete set illustrated above. In the receiving equipment space is saved by utilizing a system of amplification whereby the output of the detector tube is successively applied to it as an input until a limiting critical amplification is reached

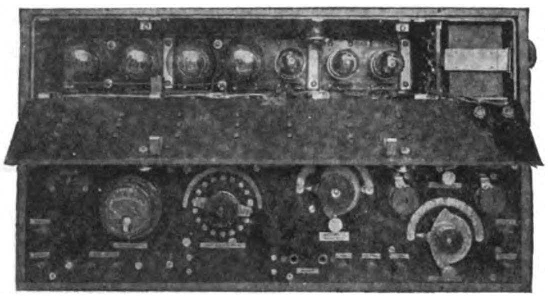


Varied Military Equipment

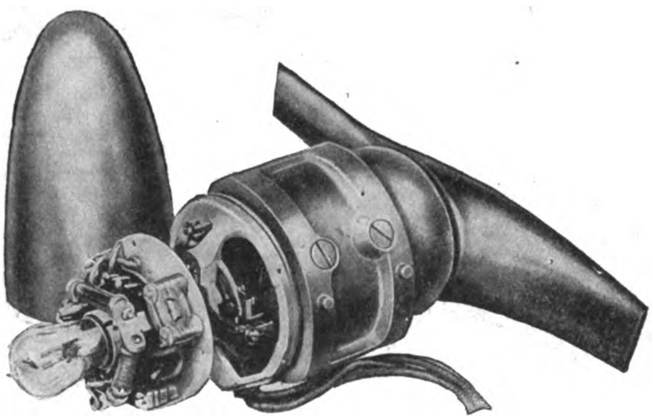




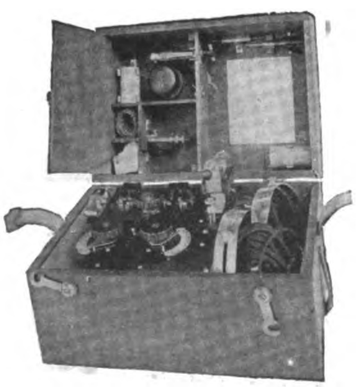
The two illustrations above are interior and exterior views of the radio telegraph set, type SCR-99, for army field use. Two vacuum tubes are used in the oscillating circuit for continuous wave transmission. This equipment is designed for beat reception of continuous wave signals and is also capable of receiving spark set signals



On the left is wireless telegraph set type SCR-78, designed especially for tanks, to enable them to advance as protected signal stations. Only the smallest antenna could be used, and the problem of obtaining the necessary power output was met by using an oscillating circuit involving four vacuum tube amplifiers

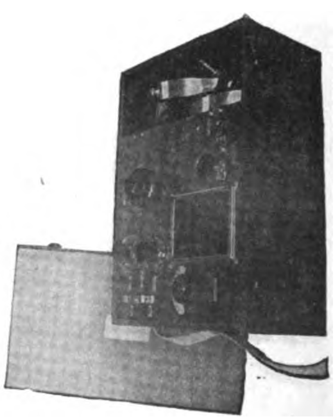


Wind-driven generator for airplane sets, showing regulator which supplies both a 24-volt current for the filaments and a 350-volt current for the plate-filament circuit. The speed of this generator, varying through wide limits, required special means for voltage regulation, found by utilizing characteristic properties of a thermionic vacuum tube, the bulb itself being mounted in the stream line extension of the generator

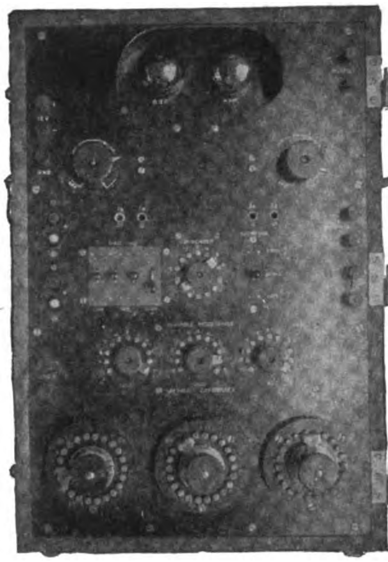


To the left is wireless telegraph receiver SCR-54, using a crystal detector and patterned on sets in use by the French Army in the earlier years of the war

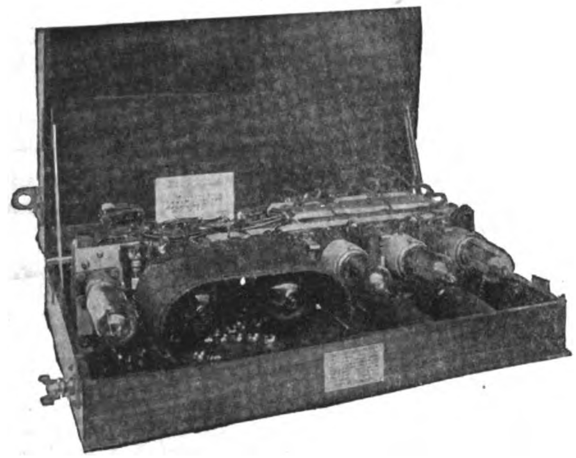
To the right, the familiar SCR-70 special wireless receiving set used in instructing aviators and other radio operators



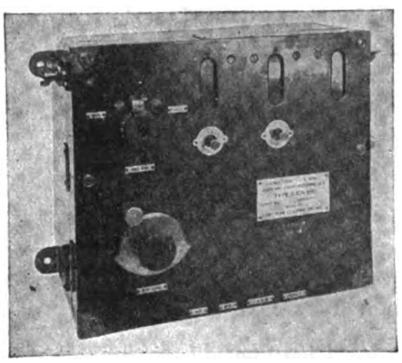
Recently Developed Apparatus



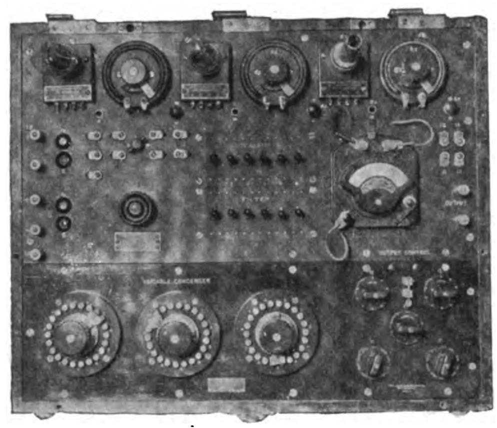
Oscillator for very low frequencies



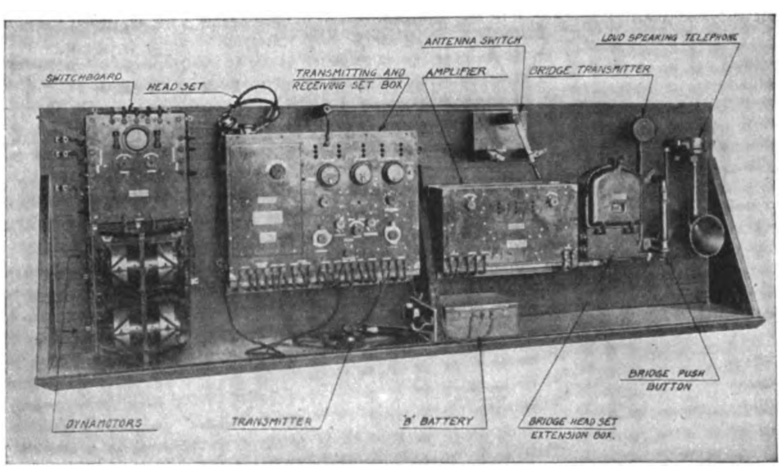
Interior view of SCR-68 wireless telephone set



Double tuned ground receiving set SCR-59



Audio frequency oscillator



Navy wireless telephone set designed for use by submarine chasers

Portable 3-stage amplifier

EXPERIMENTERS' WORLD

Views of readers on subjects and specific problems they would like to have discussed in this department will be appreciated by the Editor

A Universal Radio Receiver for Amateur Use

By Morton W. Sterns

IT has been the writer's good fortune to meet many hundreds of radio amateurs since the war began, and it has been his observation that their main concern has been to obtain the details of the design of a receiver that will permit reception over great distances for relay work. Although a variety of opinions and designs have been set forth as to what constitutes the best all around receiver, the most of them are, in the author's opinion, either too difficult to construct or too expensive for the average amateur's pocket-book.

The writer has given the matter his serious consideration for some time and has finally evolved a set which it is believed possesses many desirable characteristics. Keeping in view the desirability of an efficient receiving set that would occupy a minimum of space, a set was eventually produced that would give a range of tuning from 130 to 1850 meters with a small antenna of .0005 mfd. capacity. As will be noted further on, this same set gives a three mile range either as a radio telegraph or radio telephone transmitter. A single bulb is used for all work and the circuit has proved especially efficient on short amateur wave lengths. The entire set occupies a space less than a two foot cube. It is not only feasible for the reception of damped and undamped waves, but it gives regenerative amplification and constitutes a very neat and efficient wireless telephone set.

Fundamental Circuits

A series of exhaustive experiments with various types of circuits have been carried out. Very good results were obtained with the circuit shown in figure 1, where a three electrode vacuum tube is connected across a tuning coil

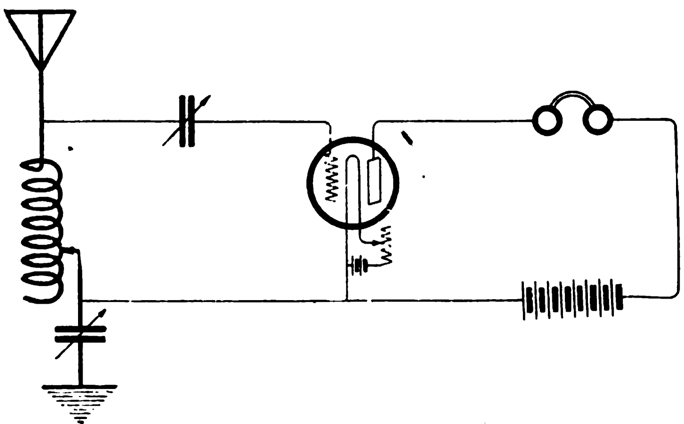


Figure 1—Fundamental circuit showing three-electrode vacuum tube connected across a tuning coil in series with the antenna circuit

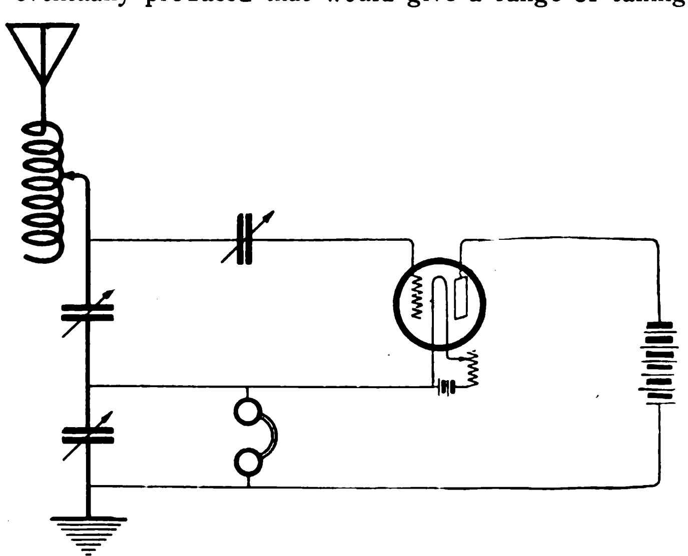


Figure 2—Another circuit using two variable condensers

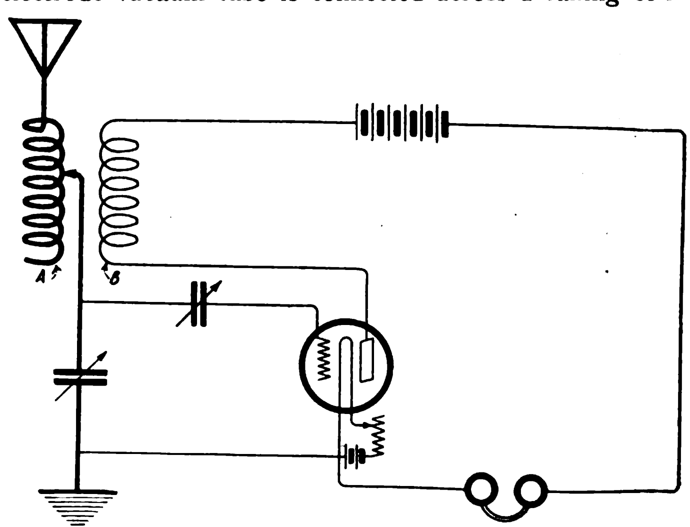


Figure 3—A circuit patented by C. V. Logwood using a regenerative coupling to transfer energy from the plate to the grid circuit

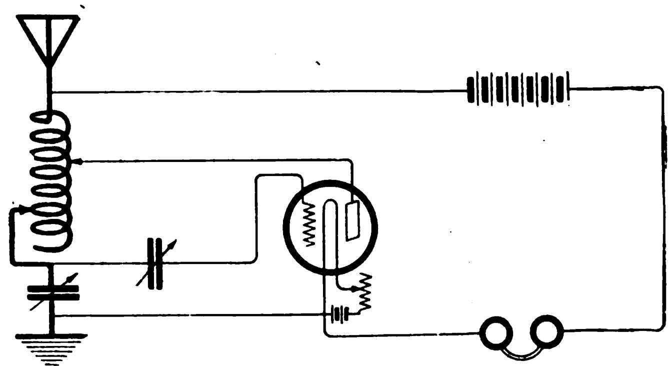


Figure 4—Circuit using one coil and one condenser and employing direct regenerative coupling between the plate and grid circuits

in series with the antenna circuit. The principal objection to this particular circuit was that it was not capable of receiving continuous wave signals.

The circuit of figure 2 was found to give very good results, but the local oscillations were not easily controlled and, furthermore, it necessitated the purchase of two variable condensers as shown.

Very satisfactory results were obtained with the circuit of figure 3 which, it is stated, has been patented by C. V. Logwood. In that diagram coil B is a tickler coil of a comparatively few turns of wire mounted inside of coil A, constituting a regenerative coupling by which energy can be transferred from the plate to the grid circuit. It is a feature of this circuit that the oscillations can be started or stopped simply by moving the coil B in and out of the coil A.

Having determined the good and bad features of the circuits described, I carried out further experiments with the view of obtaining greater simplicity. In fact, I was determined to have one coil and one condenser, and my researches eventually culminated in the circuit shown in figure 4, in which direct regenerative coupling between

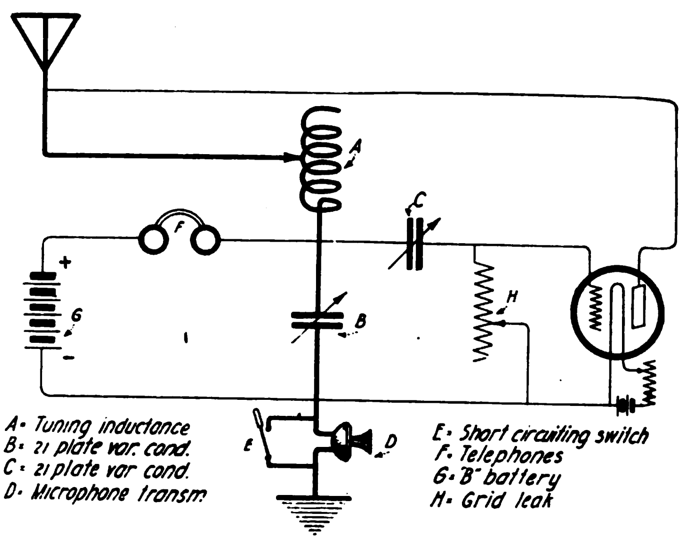


Figure 5—The perfected circuit of simple design and extremely sharp tuning

the plate and grid circuits is employed. Once having discovered a fundamental basis upon which to work, and having observed that the mutual inductance between the plate and grid circuits could be controlled by a single coil, various combinations were tried employing grid leaks, negative grid voltages, etc. Some useful results were obtained, but the experiments finally terminated in the universal circuit shown in figure 5, which it is believed is the acme of simplicity and moreover gives extremely sharp tuning.

The notations in the diagram are explained in the accompanying drawing.

Coil A in the diagram has three taps. The switch is placed on one tap and the condenser B is varied over its range until the desired signal is heard. Since the tuning is exceedingly sharp, care must be taken while adjusting this condenser not to miss the signal. It is understood, of course, that the switch E is closed while receiving, but it is interesting to note that by varying the capacity of the condenser C, the bulb can be made to give regenerative amplification or to generate powerful oscillations, hence the circuit can be used for wireless telephone transmission as well.

By way of further explanation of the circuit, H is a grid leak which is of the order of 60,000 to 100,000 ohms resistance for the audiotron or the round bulb. This leak can be made a pencil mark, between two binding posts of a Ward Leonard porcelain resistance or a graphite potentiometer such as used in the B battery circuit. The latter type is particularly handy, because it is variable. It must be understood that the grid leak is essential for proper working of the system, but once adjusted it need not be touched during the life of any particular bulb. The plate

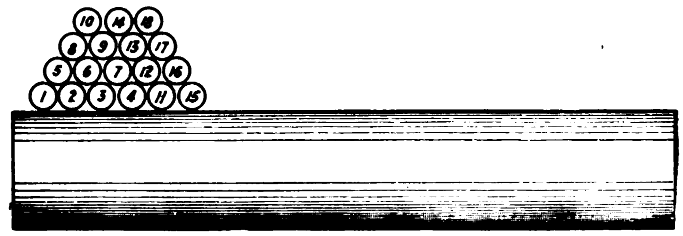


Figure 6—A four-bank winding showing the order in which the turns are placed upon the tube

circuit voltage in this system varies between 60 and 80 volts or even higher if possible.

USE OF THE CIRCUIT FOR WIRELESS TELEPHONY

To engage in wireless telephone conversation, open the switch E and speak into the microphone distinctly, making sure that the bulb is in a state of oscillation. An indicating device of some sort, such as a small ammeter, should be placed in the antenna circuit to determine the maximum antenna current. The plate voltage should be as high as possible without causing the bulb to ionize; that is, to give the characteristic blue glow. And if any amateur possesses a "hard" bulb that proved inoperative in an ordinary receiving circuit, he should now put it into use, because for transmitting purposes, the "harder" the bulb the better will be the results obtained.

In order to telegraph by means of continuous waves, place the key in series with the grid leak. This will cause the bulb to stop oscillating whenever the key is up.

In the construction of this apparatus it is preferable that the receiving cabinet proper contain only the tuning inductance and the 21-plate variable condenser. The vacuum tube control panel is separate, and a sufficient number of binding posts are brought out to allow any desired connection to the tube. The connections from the inductance switch are brought to the binding posts on the receiving panel. Other posts are provided for connection to the antenna and ground. Additional leads are brought out from the variable condenser to binding posts.

The tuning coil is wound with "litzendraht" or No. 18 B & S D.C.C. wire on a tube three inches outside diameter. A four bank winding is employed as shown in figure 6, the numbered circles showing the order in which the turns are placed upon the tube. A section of fifty turns is

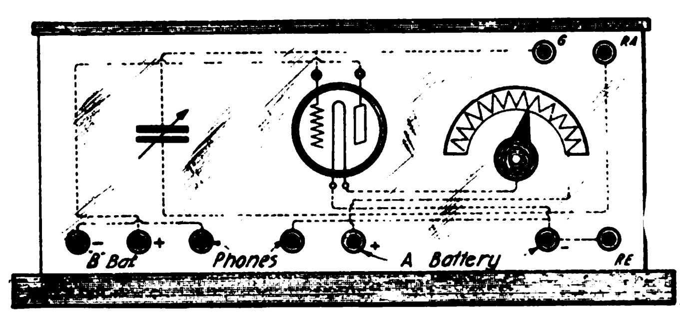


Figure 7—General view of the panel for the vacuum tube with connections

wound on the spool and a space of 3/8 of an inch is left, after which another section of 240 turns is wound on with a tap placed at each 55 turns. The writer employs, preferably, litzendraht cable composed of 42 separate strands of No. 36 B & S enameled wire with a double silk covering.

Figure 7 shows a general outline of the panel for the vacuum tube. It contains a variable condenser, the vac-

uum tube holder and a filament rheostat, all mounted inside the box. The panel is of 3/8 inch bakelite. The connections are brought out in such a way that any desired hook-up can be employed.

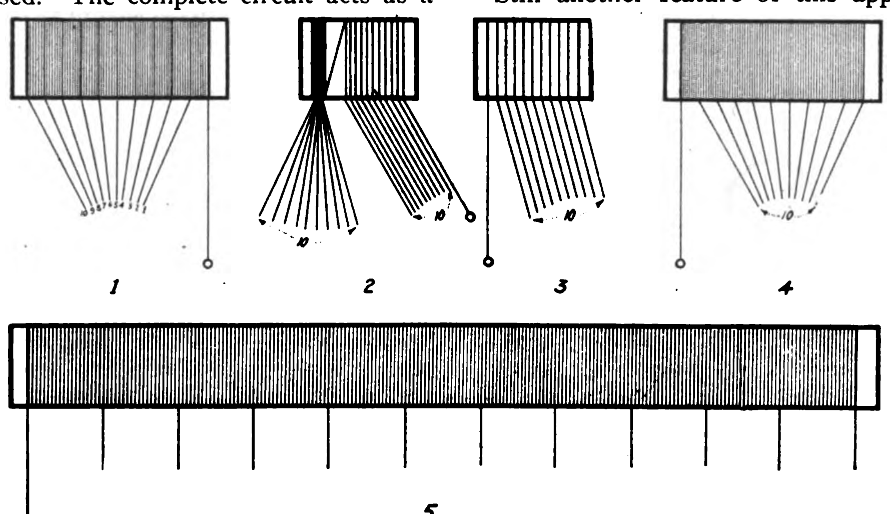
A feature of construction that the average amateur would do well to incorporate in his set is the method of fastening the panels to the box. Several right angles of 1/16 inch brass are made and screwed to the side of the box. The panel is then lowered and rests on the angles as a support, leaving the panels flush with the top of the box. Holes are then drilled through the panel and spotted in the brass angles. The holes are then reamed out to give clearance for a small machine screw; the brass in then drilled and tapped to fit the machine screw. Constructed in this way, the panel can be removed from the box as often as desired without stripping the thread in the wood, as might happen if wood screws are employed.

In closing, it is well to remark that the final circuits shown in this article can be used directly with the Western Electric "E" type tube fed from a 220 volt direct current force of supply. The bulb will give antenna current of 0.8 ampere and telephone conversations with this amount of current have been heard seven miles away. Other types of bulbs I have employed permit transmission over distances of three miles.

Constructional Details of a Wireless Receiving System Involving Weagant's "X" Circuit

By E. T. Jones

I HAVE experimented with many circuits for the reception of damped and undamped waves but the one described here gives better all-around results than any other I have used. The complete circuit acts as a detector, oscillator and amplifier for both long and short damped or undamped waves. An outstanding feature is that but one bulb is required for reception over great distances.



Constructional details of the receiving system using Weagant's "X" circuit

With a circuit of this kind I have copied signals from Nauen and Eilvese, Germany; Canarvon, Wales; Koko Head, Hawaii; Pearl Harbor, Hawaii; not to mention the arc stations located in the United States, the signals from which come in at audibilities of approximately 5,000. Signals have been read from the new high power station in Japan testing with Koko Head. These signals were plainly readable at New Orleans at 8 o'clock in the morning. One point that stands out particularly in connection with the operation of this set is, that by careful variation of the condenser capacity in the grid and plate circuits, adjustments can be obtained whereby the circuits are just on the verge of radio frequency oscillation, causing great amplification of spark signals; and by further adjustment of the condenser capacities, the circuits may be set into oscillation at any desired frequency permitting the reception of undamped waves.

Still another feature of this apparatus which I believe will appeal to the amateur experimenter is that wave lengths ranging from 600 up to 20,000 can be received without having the usual duplex receiving transformer, a multiplicity of change-over switches, etc. In fact, my entire series of experiments leads me to believe that too much praise can not be given this circuit for general experimental work. It is described in pages 102 to 105 of Bucher's "Vacuum Tubes in Wireless Communication," which explains vacuum tube detector circuits in detail.

Constructional details and dimensions of the tuner which I have found very satisfactory under the most exacting conditions follow; the antenna loading coil is wound on a tube 4" in diameter and 12" long covered with one layer of No. 24 S.C.C. magnet wire. Taps are taken off every inch, making a total of 10 taps. The winding is eleven inches in length. A general view is shown in figure 1.

A direct coupled receiving transformer is employed as shown in figure 2. It is wound on a tube 4" in diameter and 6" long covered with one layer of No. 24 S.C.C. wire. Taps are taken off every 10 turns, making a total of 20 taps. Two switches with

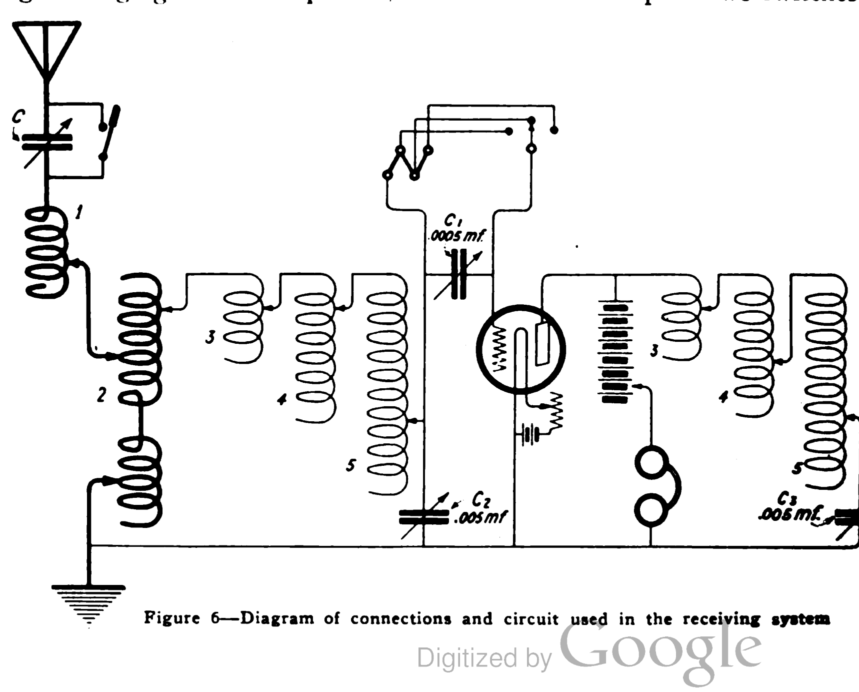


Figure 6—Diagram of connections and circuit used in the receiving system

ten contact points are provided. Each contact point is connected to successive tenth turns. A unit switch is also supplied which connects to the first ten turns, one at a time, as shown.

The short secondary coils shown in figure 3 are made on tubes 4" in diameter, 6" long wound with one layer of No. 24 S.C.C. magnet wire. Taps are taken off every half inch, making ten taps per coil, or a total of 20 taps. The two loading coils of medium length are made of tubes 4" in diameter, 12" long wound with one layer of No. 24 S.C.C. magnet wire. Taps are taken off every inch, making a total of 20 taps for the two coils.

The large loading coils for long wave lengths are made on tubes 4" in diameter, 36" long, wound with one layer of No. 24 S.C.C. magnet wire. Taps are taken off every 3". The details are shown in figure 5.

The variable condensers in the secondary circuit and plate circuits should have a capacity of at least .001 mfd.

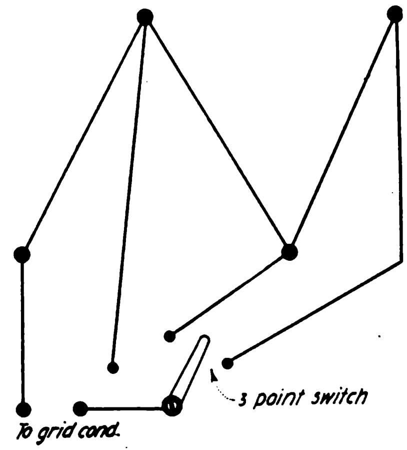


Figure 7—Diagram of connections for the three-point switch

and for the very long wave lengths a capacity of .005 mfd. is desirable. The grid condenser should not exceed a capacity of .0005 mfd. or thereabouts. A grid leak of the type shown in figure 6 is necessary for stable operation. It may be made of high resistance strips of graphite or lead pencil lines drawn in a groove, or of carbon typewriter paper. A three point switch is connected as shown in figure 7.

The receiving system shown in figure 6 is not only exceedingly stable in operation but simple of adjustment and by proper selection of inductance at the antenna loading coil 1, at the tuning transformer 2 and at the loading coils in the grid and plate circuits, a point can be found where simple variation of the capacity of the condensers C-2 and C-3 will be sufficient to cover a wide range of wave lengths. In case near-by local power lines cause interference, the filament may be grounded to earth.

A Combination Spark and Buzzer Transmitter

By William Holladay

IT is well known that the buzzer can be used for transmitting over distances up to about two or three miles. As it radiates a wave of the natural frequency of the aerial and of low decrement, and may be adjusted so as to give a 500 cycle tone, it makes a good substitute for the spark transmitter for inter-city communication. But very few amateurs are content to use a buzzer for transmitting and sooner or later they will choose a transformer for long distance communication. A transformer is not, however, well suited for short distances and the buzzer is the logical solution of such a problem. It is quite a job to change all the connections to the key, aerial and ground in order to change from the buzzer to the transformer, so I believe the accompanying circuit is the solution. The panel shows the arrangement of switches.

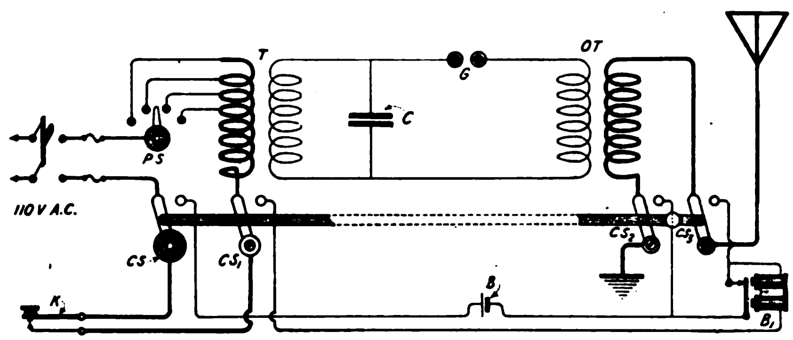


Figure 1—Circuit showing connections of switches in the combination spark and buzzer transmitter

Taking the circuit figure 1 with the switches CS, CS_1, CS_2 and CS_3, in the position shown, the current passes through the fused switch and through the reactance regulator PS, into the primary, through switch CS_1, to the key K and back to the line. The current induced in the transformer secondary charges the usual form of closed circuit, embracing the high potential condenser C, the rotary gap G and the primary of the oscillation transformer. The secondary is connected to the two remaining switches CS_2 and CS_3 to which are soldered leads to aerial and ground.

When the handle of CS is rotated, all the change-over switches are snapped to the right, and the buzzer circuit is used for transmitting. It will be seen that the current passes from the battery through the key by way of the first two switches, and the two contacts of the vibrator are connected to aerial and ground through the two switches on the right.

The switch panel shown in figure 2 should be of marble, bakelite, or other good insulating material, but for low powers well-varnished hardwood will answer the purpose. The two switches on the right, marked "G" and "A" should be about four inches long, made of copper bus-bar, with the contacts at least three inches apart. The two binding posts marked "110" are connected to the line and the "B" posts to the low voltage battery for running the buzzer. The two binding posts K on the lower part of the panel are connected to the key. It will be found better to solder the aerial and ground leads, and also the oscillation transformer leads, directly to the back of the switches. The panel should be about 15 inches long and 11 inches wide.

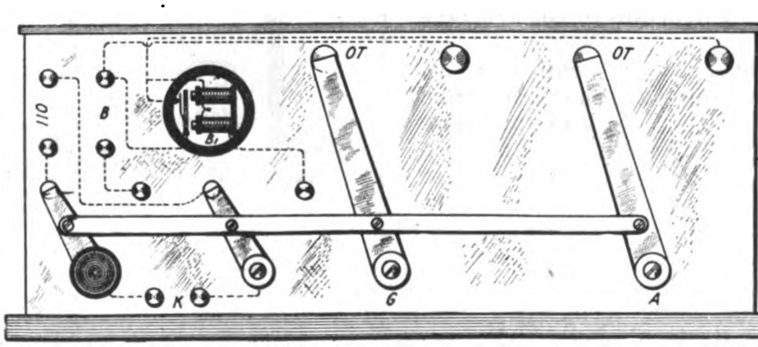


Figure 2—Panel showing arrangement and comparative sizes of switches

An Easily Constructed Oudin Coil

By R. C. Hitchcock

WHILE the amateur is obliged to abandon his radio transmitting set, he can easily construct a high frequency oscillator which may be energized by his transmitting outfit. Many interesting and startling experiments may be performed.

The coil shown in figure 1 has been successfully operated on a ½ kw. wireless transformer, using a glass condenser and straight gap. The straight gap gave high frequency sparks of greater length than a rotary gap.

The core for the secondary can be made of several pieces of cardboard, cut like the pattern and glued together, making a tube 18 inches long, 9 inches diameter at the small end and 18 inches at the other. Two wooden pieces are turned to fit the ends, and the assembly then mounted between lathe centers for winding. No. 26 wire is preferred and the turns should be spaced with a string which may be left on permanently. When the coil has been wound it should be painted with hot paraffine or some good insulating material.

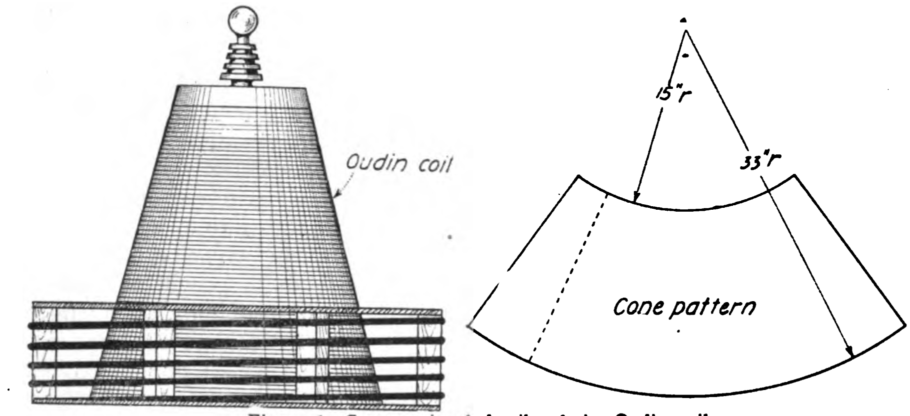


Figure 1—Constructional details of the Oudin coil

The primary is wound on a six-sided figure about 24 inches outside diameter, depending on the width of the supports. Slots for No. 8 wire are provided, six turns being sufficient for the set under consideration.

An insulator, which may be turned of wood, is mounted on the secondary to support a brass ball from which the sparks are drawn.

The secondary and primary are grounded at one end and the other connections made as shown in figure 2.

Sparks drawn into metal objects held in the hand cause no shock whatever.

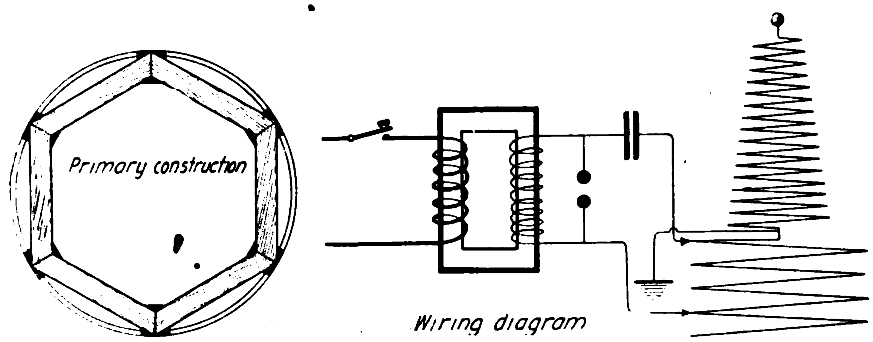


Figure 2—Primary construction and the wiring diagram

Code Practice Alternator for the Amateur

By C. J. Fitch

IT is certain that the amateur cannot expect to obtain genuine pleasure out of his radio apparatus unless he is skilled in sending and receiving. To acquire facility he needs a good code practice set. One particular way of generating artificial radio signals, doing away with the troublesome buzzer, is shown in the accompanying diagram. A small battery motor is rewound and connected in such a way as to produce a buzzing note in the head telephone. The details of construction follow:

The field is wound with No. 28 S.C.C. wire and connected in shunt to the armature. The armature coils are each wound with an equal number of turns of No. 26 S.C.C. wire. It is important that the coils be wound in the direction shown, otherwise the motor will not run. The three terminals connected at O are grounded on the rotor shaft. Connection from the battery to the shaft is made by a bronze spring wire rubbing in the groove of the small pulley mounted on the end of the shaft.

The theory of operation is as follows: When the armature is in the position shown, current flows from the battery to the + brush, through the coil C to the point O, through the coils A and B, which are connected in parallel at this instant, to the — brush and battery. The neutral wire OP will carry no current when both sides of the line are balanced. At the instant shown, however, the line is unbalanced, having two armature coils, A and B on one side and one coil C on the other. Therefore the neutral will carry the difference of current in the two sides and the current, in this case, will flow upward.

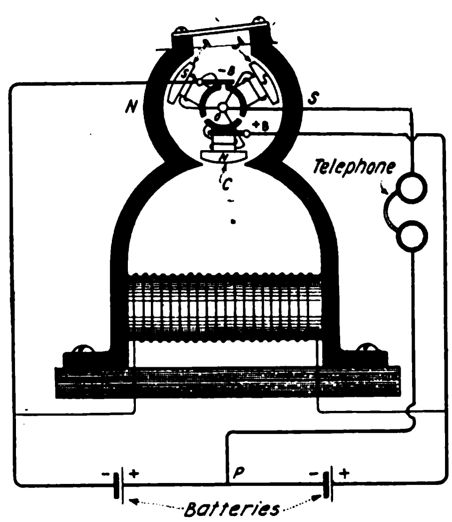


Figure 1—Showing construction and connections of the code practice alternator

The polarity of the armature and field poles when the above takes place is as indicated; the armature will rotate counter clock-wise. After the armature has rotated 60°, if the windings are traced out as before, it will be seen that two armature coils are in parallel on the side of the line which previously had one coil. In this position, the difference of current will flow down through the neutral, instead of up, as in the previous case. These reversals take place every time the armature rotates 60°, giving 6 reversals, or 3 cycles per revolution of the armature in the wire OP.

The object of the shunt field is to keep the system balanced. The series field may be used, but the current in the neutral wire will be a pulsating direct current.

No other equipment besides the motor is made use of.

Timely Advice on the Matter of Interference Between Amateur Stations

By J. E. Law, Jr.

THE amateur wireless enthusiast should exercise every means at his disposal to prevent interference. "Jamming," as wireless operators term it, may be due to any of the following causes: badly tuned transmitters; non-selective receiving apparatus; and non-observance by operators of the government regulations concerning the transmission of radiograms. Interference is not alone caused by transmitters radiating broad waves; the operator himself may lack the necessary operating skill to handle his apparatus intelligently.

One way of reducing the damping of the antenna oscillations is to select a transformer voltage suited to the set under construction, means being provided for careful regulation of its input. Abnormal spark gap voltages prevent quenching with consequent double wave emission.

The high voltage condenser should be immersed in oil to prevent brush discharge, for brush leakage is extremely detrimental to high efficiency and should be corrected before it punctures the dielectric.

The quenched spark gap is being used extensively by commercial and naval stations, and is today probably the most efficient type, since it can quickly quench out the primary oscillations before those in the antenna circuit react appreciably upon the closed circuit. The sparking surfaces of the series gap must be supported in a strictly parallel position and be kept clean. A motor blower or fan, such as is used on the Marconi panel transmitters, is required to keep the temperature at a safe value.

All leads connecting the closed circuit should be as short and as heavy as possible and should have no kinks or bends in them.

An oscillation transformer of the "pancake" type is the handiest for rapid change of wave length, but with all oscillation transformers two waves will usually be radiated if the spark gap does not quench properly and the coupling is too close. Single wave emission may be secured with any gap by reducing the coupling at the oscillation transformer. The antenna current will be reduced by this procedure. But the range of the station may be increased, because all radiation is taking place on one wave length. Careful attention to these details aid one in securing the desired sharp wave, i.e., a decrement of less than 0.2 as prescribed by law.

Nearly as important as the correct tuning of a transmitter is the provision of a selective receiving set. A vacuum tube detector permits sharper tuning than a crystal rectifier, and the use of litzendraht wire in the primary and secondary coils gives a minimum high frequency resistance. The tuning coils should be tapped so that the inductance may be varied one turn at a time. End turn switches should be used in order that turns not in use may be disconnected from those actually in the circuit.

In regard to the interference caused by the operator himself, I know it to be a fact that some operators do not always comply with the government regulations regarding the transmission of messages; when they have a message to transmit they persist in calling for a long period, even though transmission is in progress at the time. This interference is strictly *unnecessary*, with the possible exception of when urgent messages are to be transmitted. If all operators would observe the regulations governing the transmission of messages, such as the permissible wave lengths and the amount of power for a given distance, and moreover make more extensive use of abbreviations, general traffic would be dispatched with greater facility.

There are a few willful "air hogs" who want to get their messages through in a hurry and who have little respect for the other operators waiting for their turn to transmit. Let each operator, "Do unto others as he would have them do unto him," and there will be a change for the better.

An additional source of interference is the "spark coil menace," caused by "hams" disregarding every law concerning tuning, decrement, etc., and acquiring the habit of "sitting on the key."

If the government would amend the Radio Act so as to require all persons owning wireless sending stations of any power whatsoever to obtain licenses for their operation, these beginners would have some pride in their sets and strive to make them efficient. They would then realize that 200 meters means 200 *meters;* no more; no less!

Sometimes, relief may be had by paying them a friendly visit and urging them to join a wireless club where they can be taught the fundamental principles of wireless telegraphy.

Another way to decrease interference among these experimenters is to organize them all and plan out some sort of working schedule for testing periods and small talk, reserving other hours for long distance work and relaying, at which time no other transmission is to be allowed. As amateur organizations increase, doubtless some such schedule will become effective everywhere.

Ground Telegraphy

By Gerald Ehinger

THE theory of the ground telegraph is generally understood but it is not often used by amateurs. The underlying idea is to connect land line wires to earth at two points and utilize a buzzer at the transmitter station to impress variable electromotive forces upon the conducting earth. A fundamental diagram is shown in figure 1, where the transmitter includes a battery, key, and a high toned buzzer. At the receiving station, a telephone receiver is connected between two grounds as shown.

The power for the transmitter may be drawn from dry cells, storage batteries or a step-down transformer. A "break in" system is secured by connecting a condenser in the circuit as in figure 2. The working of the ap-

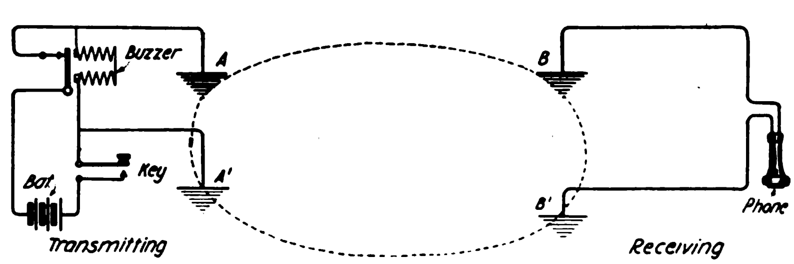


Figure 1—Fundamental circuit for ground telegraphy

paratus should be clear from the drawing.

The receiving telephone should have a low resistance; in fact, the lower the better. High resistance telephones can be used if connected to the secondary of a 1" coil (spark), the primary being connected into the circuit. A small spark coil may be used instead of a buzzer for transmitting purposes, but it is not as efficient.

Connections at the transmitter and receiver could be made to water and gas pipes, but the signals at the receiver will not be so strong as in the arrangement I have described.

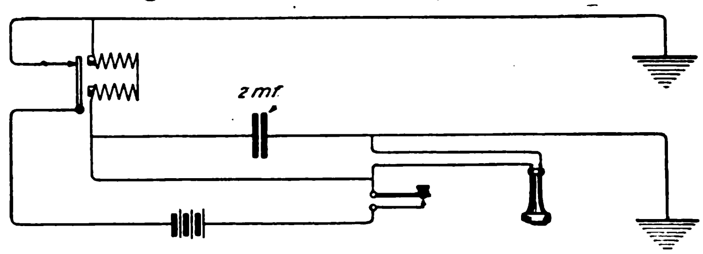


Figure 2—The "Break-in" system with condenser connected in the circuit

A Short Wave Receiver for the Amateur Station

By Carleton Howiler

I BELIEVE that the most efficient type of short wave receiver is that which employs variometers as the primary and secondary inductances. Hence the amount of inductance required to reach a wave-length of 200 meters is relatively small, and the losses in the variometers themselves are negligible.

The diagram, figure 1, shows the circuit preferred for amateur use. L-1 is the antenna variometer and L-2 the variometer which acts as one of the tuning elements of the secondary circuit. It is shunted by the variable condenser C-2. In series with L-1 and L-2 is the variable condenser C-1 which has the effect of changing the coupling between the antenna and detector circuits. A small grid condenser C-3 of about .0005 mfd. is connected in series as shown. The plate circuit of the vacuum tube is energized by the battery B shunted by the potentiometer P-1, which may be of 3,000 ohms resistance. For additional amplification some part of the plate circuit may be placed in inductive relation to the grid circuit of the tube, but very good results will be obtained with the simple circuit shown.

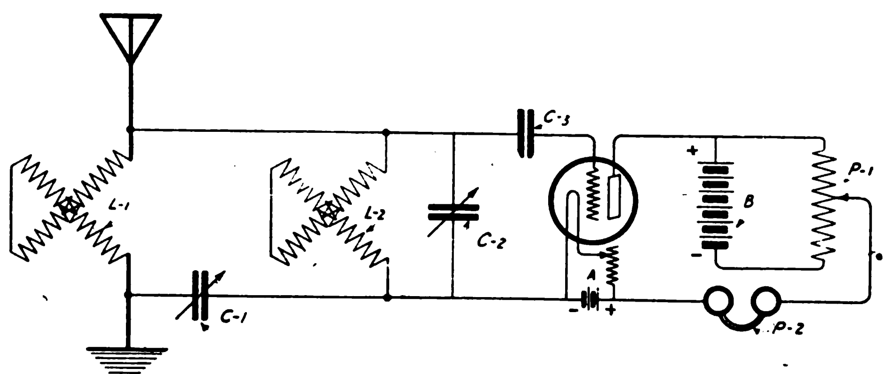


Figure 1—Circuit of the short wave receiver suitable for amateur stations

The variometers are identical in construction. Each consist of two cardboard cylinders 1½ inches wide. The larger cylinder is 4½ inches in diameter and the smaller one 4 inches in diameter. Both are wound with the same number of turns of No. 26 S.C.C. wire.

I prefer to mount the variometers and variable condensers in opposite corners of a cabinet. The panel on which the vacuum tube detectors are mounted can be secured to the top, giving a very neat appearance.

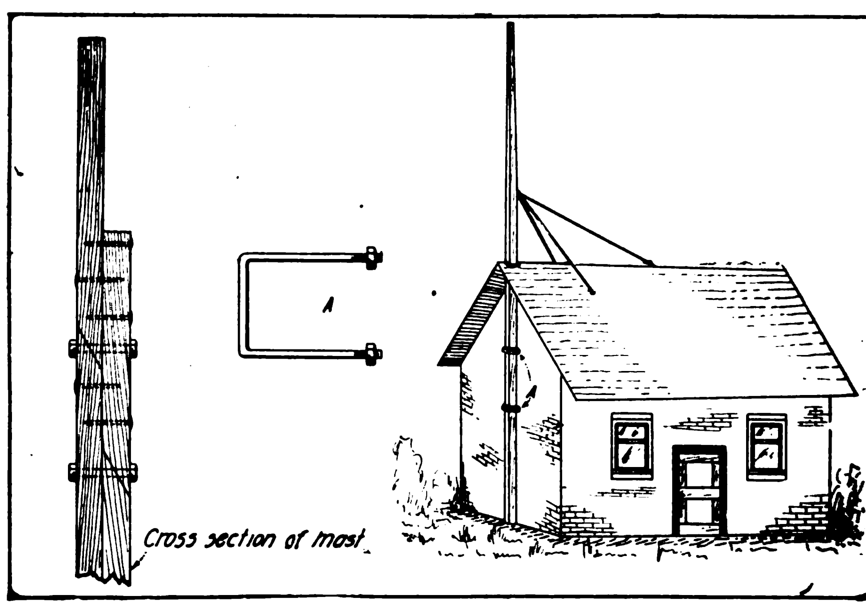
I am sure that with these few constructional details and a careful study of the diagrams, any amateur can readily build a set that will do far better work on short waves than the average amateur equipment.

An Aerial Mast on the Roof

THE amateur located in the country or a small town may be interested in the design of an aerial mast constructed as shown in the accompanying drawings. It will be noted that a hole is cut in the roof of the building through which the mast enters and that the mast is clamped to the side of the building by means of two iron rods of the shape shown in the figure at A, which are threaded at both ends to take a bolt.

The mast may be put together in sections, one at a time, and slid up through the holding clamps. By using pieces of two by four lumber 16 feet long, a very serviceable mast is obtained. Two or three 16 foot pieces will be sufficient for the average amateur aerial mast.

HENRY KLAUS, *Illinois.*



A Cat Whisker Detector Stand

A DETECTOR holder with universal adjustments devised by S. S. Jones is shown in figure 1. By the use of the ball joints 4 and 5, the crystal can be set at any desired angle without removing from its holder, so that any sensitive spot on the crystal can readily be located.

The friction in the claw and ball joints is increased or decreased by means of a screw 9 acting upon the ball through the bottom of the cup. The crystal is held between the jaws of a spring clamp 2 mounted on the ball 4. Experimenters possessing the facilities for the construction, will undoubtedly find this a very convenient and practical detector stand.

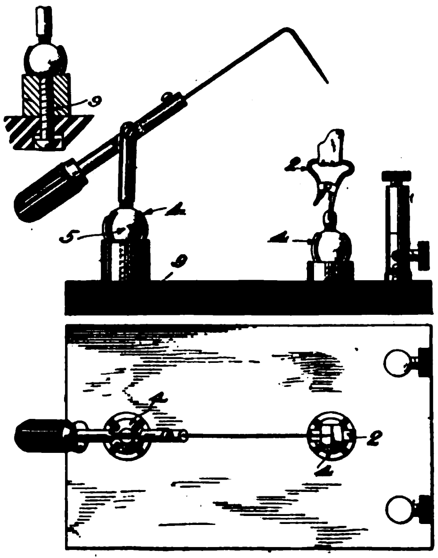


Figure 1—Showing construction and assembly of the cat-whisker detector stand

Amateur War Work

I AM a non-commissioned officer in the radio branch of the U. S. Signal Corps and have had many an opportunity to see the value the radio operator has been to the Army in France. The best of the signal personnel are former, or pre-war, amateurs who operated amateur stations and enlisted like myself when the war broke out.

A little incident in which I took part during the great drive we made against the Hun will show why the radio amateur should be encouraged.

One dark night we could not raise 4 - - -, who was located about a half mile forward of us. After calling several times we decided to go and see what was wrong. Station 4 - - - was manned by radio men who got what radio experience they ever had in the Signal Corps. To reach them we had to drive a motorcycle, another lad and I, over a road which was undergoing the worst shelling by the Huns it ever had. But we arrived O. K. We were using a sustained wave transmitter of the bulb type and the high tension battery was made up of a large number of 40 volt storage batteries. Upon examination of the Station 4 - - - set we found this battery circuit open.

We of course put the station working in short order. The point of the incident—only one of many incidents —is that the amateur radio men have shown themselves far superior to those who were taught wireless in the Service. And while we were still in uniform and not able to make an organized protest against Congressional action, they tried to wipe us off the map. Fine recognition of valuable service well rendered. I am sending these few lines to the N. W. A. by request of the amateurs in our outfit, which number up pretty high.

Corporal E. J. Atkinson *(formerly 1QV), 302nd Field Sig. Bn., A. E. F., France.*

Safeguarding Our President By Radio

EXTRAORDINARY efforts were made by the U. S. Navy Department to maintain continuous radio communication with the U. S. S. George Washington, carrying the President of the United States and his official party to France. As is well known, the vessel was convoyed by the U. S. S. Pennsylvania, which was equipped with powerful wireless transmitting and receiving apparatus. Four high power undamped wave transmitting land stations were employed to transmit to and receive from the George Washington, the Annapolis arc set transmitting on 16,900 meters, the arc set at Tuckerton, N. J., on 9,200 meters and the Marconi radio frequency alternator set at New Brunswick, N. J., on 13,000 meters. The Government high power station at Lyons, France, transmitted on 15,500 meters.

The battleship Pennsylvania's radio equipment consisted of a 30 kw. arc transmitter, which was used for transmitting messages to the United States and France on the wave length of 3,600 meters; also one 10 kw. quenched spark transmitter working on 600 and 952 meters, which was employed for communication with low power land stations; a short range radio telephone transmitter working on 297 meters, and one vacuum tube radio telegraph set transmitting on 450 meters. The latter was used for communicating between the U. S. S. George Washington and her convoy, the Pennsylvania. The Pennsylvania worked United States stations up to 2,500 miles and communication was established with Lyons, France, before the Pennsylvania was out of range with the United States.

The Pennsylvania's radio cabin was fitted with six receiving booths which were able to receive at eight different tunes simultaneously as follows: One booth was on constant watch for the 297 meter telephone signal and another booth guarded the 450 meter vacuum tube transmitting set for communication with the Pennsylvania. Another operator on a separate receiving set stood by on 4,000 meters, which is the standard arc calling tune; the fourth receiver guarded Lyons' wave length of 15,500 meters and the fifth guarded Tuckerton's tune, 9,200 meters. The sixth set was kept on constant watch to pick up signals from Annapolis or the Marconi New Brunswick station at 16,900 and 13,000 meters respectively. Another operator with a distinct receiving set and antenna guarded 600 and 952 meters. The principal receiving station in the United States was that located at Otter Cliffs, Me., but other stations were also kept on watch for the reception of signals. On the other side, the reception of signals was effected at Lyons, France.

Suggestion for Prize Contest, July Issue Wireless Age

We will pay the usual prizes of $10, $5 and $3, in addition to our regular space rates, to the three contributors who send us the best manuscripts on the following subject:

"What are the relative merits of the regenerative vacuum tube receiver and the cascade vacuum tube amplifier for radio reception at amateur wave length?"

The radio equipment on the U. S. S. George Washington consisted of a low power spark transmitting set, a 16,900 meter long wave receiving set, one 600 meter spark receiving set, one short wave radio telephone transmitting and receiving set and one vacuum tube 450 meter telegraph transmitting and receiving set.

The George Washington was able to take down messages transmitted from the Annapolis or New Brunswick station and at the same time keep an efficient watch on the wave length of 600 meters, intercept commercial signals, emergency signals or messages transmitted by radio telephone or vacuum tube transmitters, simultaneously.

The messages intended for the George Washington were received principally on the Pennsylvania and relayed to the George Washington by means of the wireless telephone and vacuum tube telegraph set, simultaneously.

A Simple Method of Tuning the Amateur Transmitter

SINCE the declaration of peace seems a short time off and the whole tribe of amateurs are looking forward to the day when they will be able to revert to the peaceful pursuit of radio telegraphy, the following method of tuning the transmitting apparatus to the required wave of 200 meters will, because of its simplicity, and because of the fact that no wave meter is required, appeal to many suburbanites and less wealthy experimenters, who are unable to procure the use of a calibrated instrument:

An exploring coil of optional dimensions (six or eight turns of No. 20 wire around a short cardboard tube having a diameter of 3 or 4 inches, is satisfactory) is inserted in series with the secondary of the loose coupler of the ordinary short wave receiving circuit. Using a minimum degree of coupling, the receiving apparatus is tuned to the signals of a station having a known 200 meter wave. When these adjustments have been made as accurately as possible, the loose coupler secondary is moved from inductive relationship with the primary, in order to avoid mutual inductance between the two, which would affect the accuracy of the readings.

The complete secondary circuit of the receiving apparatus now forms a wave meter, permanently adjusted to a wave length of 200 meters, the telephones being employed to find resonance as in a standard wave meter. The transmitting apparatus may now be tuned by any one of the commonly used methods. Perhaps the most satisfactory method for our purpose is to excite the aerial by means of a small buzzer, connecting the buzzer contacts to aerial and ground respectively. The buzzer is set into operation, and the exploring coil of the wave meter is brought into juxtaposition with the secondary of the oscillation transformer, so that the buzzer signals are barely audible. The inductance of the oscillation transformer is changed until maximum response is noted in the telephones. The transmitting set next is put into operation and, using a small value of coupling, the oscillation transformer primary inductance is changed until the aerial ammeter or pilot lamp shows a maximum reading. The critical value of coupling to be employed may be ascertained from the other fellow, who can inform you when your wave becomes too broad.

SGT. MAJ. CHARLES MANLEY—*Amer. Exped. Forces, France.*

Contest Winners for June

The April subject for discussion was: "Which of the two following types of wireless transmitter do you consider to be the most practical for amateur use, namely: the panel type or the isolated instrument type?" Prizes have been awarded to the writers of the following articles.

First Prize—The Panel Transmitter Versus the Isolated Instrument Type

TO my mind, the question as to whether the panel or isolated instrument type of transmitter is the more practical is not difficult to answer. While it cannot be denied that the isolated instrument type has given good results and that some amateurs will continue to use it after the ban is lifted, yet there can be no argument against the superiority of the panel transmitter.

A particular advantage of panel mounting is the reduction of the length of the leads in the oscillation circuits. This is a vital factor when we take into consideration that the maximum capacity of the condenser of the amateur transmitting circuit can not exceed .008 mfd.; for otherwise, the wave length of the closed oscillation circuit will exceed the government restriction. In addition to the lead reduction advantage, the panel transmitter permits centralization of control. This is of especial importance when rapid changes in the circuits are to be made, such as changing the radiated wave length. Then, too, the panel set takes up less space and it presents a much better appearance. Any amateur will agree with the latter conclusion after once having seen some stations in which the various instruments, such as the transformer, condenser and spark gap are scattered around the floor. Such haphazard installation is not only uncalled for, but it displays ignorance on the part of the owner in regard to the fundamental requirements of an efficient station.

It is often argued that the instruments of the isolated type of transmitter are more accessible for repair; but to my way of thinking, if the panel type is properly designed it is just as accessible as any other type.

I like particularly the transmitter

described by Mr. Zahorsky in the April issue of THE WIRELESS AGE, but I am inclined to believe that a neater set would result if the experimenters would mount their apparatus behind the panel as is done in standard Marconi sets. While on this point, I would urge that amateurs study the good points of the Marconi panel transmitters described in "Practical Wireless Telegraphy."

The experimenter should realize that commercial companies have sifted this matter down to the last detail and their panel designs are undoubtedly the result of extended experience. Why not make good use of that experience?

The writer once designed a transmitting set which consumed one-sixteenth kilowatt; the instruments, comprising the complete set, were arranged on a table in as efficient a manner as was possible. Later, these instruments were mounted on a panel and increased range of transmission was secured. This was undoubtedly due to the use of short connecting leads, particularly in the spark gap circuit.

I do not think it advisable to suggest a particular design for an efficient panel set, for I believe it to be impossible to put forth suggestions that would be acceptable to all; besides which, the arrangement of the apparatus on the board would depend upon the type of transmitter used. As far as I am personally concerned, the panel set is the only type to which I would give serious consideration.

N. W. LOCKWOOD, *Pennsylvania.*

Second Prize—Panel Versus Isolated Instrument Type of Amateur Radio Transmitter

UNLIKE radio receiving outfits, the hook-ups for transmitting outfits are limited, and are practically on a par, so far as the efficiency of the set is concerned. The amateur's sending set generally consists of the following instruments: key, step-up transformer, condensers, spark-gap, oscillation transformer, and usually a hot-wire ammeter. There are but two schemes in general use (see figures 1 and 2) for connecting these instruments, and they are practically identical in regard to efficiency.

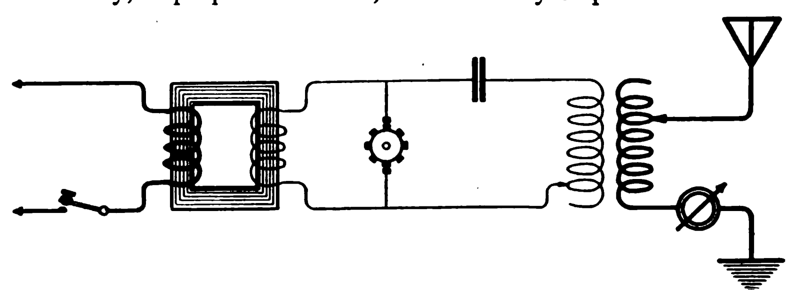


Figure 1—Standard hook-up for amateur panel transmitting set

The first factor for the amateur to consider in the design of his transmitter is to arrange and design the instruments so that the radiated wave length will comply with the laws governing amateur or experimental transmitting stations. To keep the wave length within the restrictions imposed by law, the shortest possible connections should be used. Next in importance is the insulation problem. Leakage is the source of large losses, but it can easily be prevented.

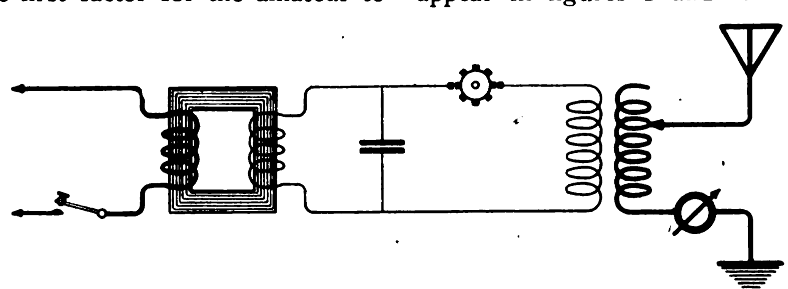


Figure 2—Another form of figure 1

Now for the particular advantages the panel type possesses over the isolated instrument type: It is not necessary or desirable to isolate the several instruments in order that different hook-ups may be tried, because they have all been tried, and the best ones appear in figures 1 and 2. It is a well known fact that it is a much easier matter to make short connections when the instruments are mounted on a panel. Good insulation can be had in either method. I have

seen panel transmitting sets in which nearly all connecting wires, binding posts, etc., were imbedded in an insulating compound, making them weather and "fool" proof. With regard to the comparative ease of operation of the two types, they are on a par, and depend entirely upon the forethought used in installation.

Finally, I am sure the readers of THE WIRELESS AGE will agree that, as a rule, the panel type amateur transmitter, although slightly more expensive, has a decided advantage in neatness and appearance as compared with the old fashioned, isolated instrument type.

L. W. VAN SLYCK, *Michigan.*

Third Prize—The Panel Transmitter

AMATEUR transmitting sets may be divided into two general classes: The panel type, in which the instruments are arranged in a compact, systematic manner and the isolated instrument type, in which they are scattered about without regard to over-all efficiency. For the amateur who wishes to get the best results from his sending set, the panel type is by far the most desirable of the two. The efficiency of a transmitting set will be remarkably increased by panel mounting, principally because of the reduced length of the leads in the oscillating circuits. In addition, this construction provides better insulation.

Arrangement of the instruments, one above the other, in logical order, permits short leads which need not cross each other and in the matter of insulation each separate instrument has its own rack, thus doing away with leakage or cross induction. Thus the panel transmitter affords a remedy for the two greatest defects of the isolated instrument type.

A most important factor in operating sending apparatus is the assurance of safety to both the operator and instruments. The panel, because of the small floor space it requires, can be placed in a convenient position where it will not injure the receiving instruments. The only wires required to operate the panel at any distance are those leading to the key and to the rotary gap switch. In this set, moreover, the apparatus, situated behind a protecting panel, is in no danger of being jarred, upset, broken, or put out of adjustment as may be the case when the apparatus is spread all over the room. And not only are the instruments and their connecting wires removed from the operator's very elbow, but further, all wires are mounted behind the panel, eliminating the danger of shock to any one while sending.

Compactness, a valuable quality in any set, is a feature of the panel transmitter. The manner of arranging the instruments one over the other naturally makes a compact set. Indeed, a panel equipped with ordinary amateur apparatus can easily be mounted in a space, 4 feet by 3 feet by 2 feet. This compactness facilitates quick adjustment and renders the set portable. In this feature, the panel has a great advantage over the old type, in which the willy-nilly arrangement of the component parts makes adjustment difficult and quick moving impossible.

While not important in respect to efficiency, an always outstanding feature of a transmitting set is its appearance. In a panel transmitter the orderly arrangement of the apparatus gives a pleasing effect. In some types of panels all of the instruments are back of the panel itself, while in others, they are on the front. There are numerous models of each type, which have been described in previous issues of THE WIRELESS AGE, all of which would give a station a distinctive appearance.

Now, as to the objections to the panel transmitter: Many amateurs have the idea that such a set is large, expensive and distinctly professional. Others think that it is difficult to operate. In the first place, a panel set is not big and cumbersome. I have never seen a diagram for a panel which was larger than 5 feet from floor to top, 3 feet across the front and 3 feet from extreme back to front. In fact, one of such dimensions is unusually large. So, if the amateur can stand upright in his wireless room, he has more space than is needed to erect a panel. It would occupy, if of usual dimensions, about 6 square feet, that is, approximately 3 by 2 feet, whereas the old type transmitter requires usually double or triple that amount of space.

The apparatus used in a panel set is exactly the same as that of the ordinary amateur set. To change to a panel set, it is only necessary to transfer the instruments from their present isolated locations to the well-arranged shelves made for them in the panel. The only added expense is in making the panel, an easy task for any amateur handy with tools. This light cost is more than made up for by the efficiency and pleasing appearance of the finished panel.

Backed by the experience and opinions of some of the foremost authorities on wireless in this country, I strongly advise and in fact urge amateurs to discard the old method of isolated arrangement, and to place their apparatus in a vastly more practical form, i.e., build a panel transmitter.

HARRY HEMPHILL, *New Jersey.*

The Monthly Service Bulletin of the

NATIONAL WIRELESS ASSOCIATION

Founded to promote the best interests of radio communication among wireless amateurs in America

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Pittsburgh Club Resumes

A CAMPAIGN for membership has been instituted by the Pittsburgh Radio Club, an organization which was formed some time before the war. Regular meetings will be held at stated intervals, where the members can get together and discuss the various problems in which they are interested, arrange relay systems, tests of equipment and other activities. Interesting talks will be scheduled on such subjects as the construction of some particularly efficient piece of apparatus, wave-lengths and tuning, description and explanation of any new and interesting radio apparatus, wireless legislation and amateur experiences in the service during the war.

Another and very important function of this club will be that of teaching the International Morse (Continental) Code to all those who are not now as proficient as they would like to be. Burton Williams, president of the club, was in the Signal Corps, U. S. A., and later was Government instructor at the school for training radio operators installed in the Carnegie Institute of Technology.

It is proposed to install complete sending and receiving equipment in the club rooms for the benefit of all the members, the present plan being to use two aerials; one long one for receiving, and a 200 meter aerial for sending. The equipment will also include an omnigraph and buzzer practice sets for code practice.. It is further proposed to subscribe for the leading wireless magazines and endeavor to have a library section.

Invitations to seek membership are issued to all amateurs. C. E. Urban, 26 Watson Boulevard, N. S., Pittsburgh, Pa., is secretary of the club.

Regarding Restrictions on Amateur Stations

THE radio stations of the United States may be classified into three types, namely; commercial (including ship and shore stations), government and amateur stations. The first two types are essential to the nation for commercial and military reasons. The amateur stations are extremely useful to the country largely on account of their educational influence on the future wireless operator.

In the early days, because of the comparatively small number of radio stations in operation, the matter of interference was a negligible factor, but with the rapid increase of stations during the last ten years, interference has become such an important problem as to require regulation. As all radio men are aware, the authority to regulate the wave lengths and power employed has been delegated to the Department of Commerce.

In my opinion, the only way to eliminate interference is to classify stations according to their importance and have them operate in a region of defined wave lengths. The amateur has been allotted any wave length up to 200 meters and in exceptional cases wave lengths in excess of this figure. The principal objection to some amateur stations is, that they are not carefully constructed and properly tuned and as a consequence they radiate what is termed a "broad wave." This, of course, is in violation of the wireless statutes and creates a great deal of unnecessary interference. In some cases the emission of a broad wave is due to the use of the direct aerial connection, that is, the spark gap is placed in series with the antenna. If the authorities would compel the use of coupled circuits, this difficulty would be largely eliminated. In fact, in the writer's opinion, if regulations were enacted restricting the use of broad waves, the actual wave length used by the amateur, particularly in certain localities, would make little difference.

I would suggest that amateur transmitting stations be divided into two

classes. In the first class we would place such stations as would do purely local transmission; and in the second class, those who intend to transmit over great distances. I would urge that the amateurs in the first class be permitted to operate in 150 meters and those in the second class on wave lengths up to 250 meters. If this policy was adopted, the local amateurs would not interfere with those doing long distance work. Furthermore, those in the first class might be allowed to operate their apparatus without obtaining a license provided they will conform to the regulations concerning wave length, power, etc.; but those entered in the second class should be required to pass an examination covering their proficiency in the telegraph code, technical knowledge, etc.

Amateurs in the first class would be limited to spark coil transmitters or alternating transmitters of equivalent low power. Those in the second class should be allowed to use power inputs up to 1 kw. Amateur stations in the vicinity of commercial or naval stations should be limited to the same power input as in the past.

It is the moral duty of every amateur wireless operator to do everything in his power to prevent interference with commercial or government stations and there is no reason why he should not take a similar attitude toward amateur stations. The experimenter also should be educated to make use of variable power inputs and to use no more power than is necessary to cover a given distance.

J. C. MORRIS, JR.—*Louisiana.*

Vibration as a Basis of Invention

THE person who would give to the world some great invention must not deceive himself into thinking that he can do it by creative processes. It is not our function to create. It is our province only to adapt the laws and forces already in existence to our needs. The process is really a relative rather than a creative one. The laws and forces are here. It is our work to relate ourselves to them. One cannot build a machine that will do anything. He can only construct a mechanism through which the already existing laws of nature can operate.

Another mistake apt to be made by the amateur, and one which will lead him farther away from instead of nearer to success, is the entertainment of the notion that a wonderful mechanism must necessarily be complex. The wonderful thing about nature, after all, is its simplicity. The mechanism which is to establish a point of contact between us and a force of nature must be as simple in its principle as the force itself.

The notable thing about almost any of our great inventions is the simplicity of their design and operative principle. After observing the action of any of them one is quite apt to turn away and inwardly remark that he could have done the same thing himself if he had only thought of it. Of course, the chief approach to any notable achievement is the matter of thinking of it. Most of us do not think of these things, and the reason is often the fact that we are looking for something complex when the real principle is very simple.

The problem of the would-be inventor or discoverer, then, is not one of adding something to the universe as it stands. His work is to ponder the forces that have long operated and the laws by which they have operated, and then relate his work to some one of them. One of the chief of these, and one upon which some of our notable inventions have been based, is the universal fact of vibration.

The first great inventions which are based upon the vibration theory were made long before any of us were born and each of us has been given a free sample of both. One is named the eye, while the other is known as the ear. So far as that is concerned the work of the actual nerves at the surface of the skin is based upon the same principle.

The other day in a medical laboratory I was examining a dissection of the human head made with a view to showing the nerves in their relation to the spinal trunk and to the brain. The brain had been removed down to where its base rests upon the spinal stem. I was not so much interested in the countless fibers running off from the entire length of the spinal cord nearly so much as the two sets of nerves which have to do with seeing and hearing. Off from the spinal stem, just below the base of the brain, two large nerves ran forward to the eyes, and two other large ones ran aside to the ears. These were the optic and the auditory nerves, respectively.

These are the means which the Ruling Genius of the universe has established by which the person may maintain his contact with the outward world. One of these sets takes up vibrations and reports them in terms of light. The other takes vibrations and reports them in terms of sound. The two sets look almost precisely alike. The means by which they are made to distinguish vibrations into these two different forms of interpretation remains a mystery, unless it be that they are made sensitive only to given lengths and types of waves.

The eye was the first camera, and the inventor of the photographic process necessarily had to base his work on precisely the same principle. A

sensitive surface had to be provided; a means had to be established whereby it might receive and be affected by ether vibrations of given lengths; then the result, which in the case of the eye is so temporary, had to be chemically fixed and thereby rendered permanent.

The phonographic process is related to the vibration theory of sound just as the photographic process is based upon the wave theory of light. A phonographic record is simply the photograph of a sound. A surface had to be provided which was capable of receiving the record of the vibrations which make a given sound. The means had to be provided by which they could be permanently recorded there. Then a mechanism capable of reproducing them made the phonograph complete. The same effect was produced upon the ear as would have been produced by the original vibrations themselves. Thereby the thing which is fleeting and temporary to the ear was rendered more or less permanent. These two inventions proved once and for all the truth of the theories on which they were based.

Telegraphy and telephony, both ordinary and wireless, are likewise based upon phases of the vibration principle. Each in its day has been revolutionary. We, are, however, only upon the threshold of achievement in these vibratory means of communication. Each is simple, when once achieved, because each is based on ordinary and everyday laws of nature. Those who are improving upon the processes already established are not those who are trying to find different paths. They are those who are seeking a closer acquaintance with natural laws as they are, and who are seeking better ways of relating ourselves to those laws. We cannot alter natural forces. We can only improve upon their use.

There is a great field for scientific and inventive progress of an intensive nature. As we move forward in the effort to gain a little firmer hold upon natural processes we find ourselves able to throw away today equipment which was very necessary yesterday. First, we could carry communication farther and better with metal media between the communicating points. Now we do it equally well without the artificial media.

A few years ago a scientist announced that he could accumulate, concentrate, and unloose a vibratory force sufficient to wreck the planet on which we live. Should anyone want to do such a thing, and should the rest of the world be willing, there is little doubt that such a thing would be possible. There is probably no limit to the harm that could be done by harnessing up the ever-present vibrations to an evil end. Neither is there

any limit to the good they can be made to do when intelligently turned to worthy purposes.

Probably the statement of the scientist mentioned above was, after all, only a part of the truth. Someone has said that one cannot move his finger without displacing the elements of the universe all the way to the farthest star. Vibration is not only here but everywhere. It carries light to us from so far that years are required for the journey. It is not inconceivable that it might be made to do the same with sound.

Certainly it could be made to do the same with ideas if two conditions could be fulfilled. First, there would have to be living and intelligent beings elsewhere in the universe. Second, there would have to be a common code or basis of interpretation between ourselves and them. About the first we do not know. As to the second, no one yet sees how to accomplish such a thing. Archimedes could have moved the world with a lever if he had only had a place to stand, but of course he did not have it, so the possibility was spoiled. The principle of the lever, however, held just as good as though the impossible condition could have been fulfilled. Likewise, the law of vibrations would permit of a system of wireless out into the reaches of space. The difficulty is not with the law.

Nature probably holds some provision for our every want. We need only to establish the means by which she can deliver her gifts to us. The universe thrills with life and action. Out of its heart-throbs we shall be able to gather many a blessing.

CLARENCE E. FLYNN—*Indiana.*

Queries Answered

Answers will be given in this department to questions of subscribers, covering the full range of wireless subjects, but only those which relate to the technical phases of the art and which are of general interest to readers will be published here. The subscriber's name and address must be given in all letters and only one side of the paper written on; where diagrams are necessary they must be on a separate sheet and drawn with India ink. Not more than five questions of one reader can be answered in the same issue. To receive attention these rules must be rigidly observed.

Positively no Questions Answered by Mail.

E. B. N., Dallas, Texas:

The use of closed coil or frame aerials is perfectly feasible in amateur radio reception, if an efficient amplifier is provided to bring the signals up to audibility. Frames 4 to 5 feet square can be employed for transatlantic reception with multi-stage amplifiers. The natural wave length of the closed circuit loop should be somewhat near to the wave length to be received. For amateur reception a coil 7 to 9 feet square wound with three turns of wire spaced ½ inch will give very good results, but the plane of the coil must point in the direction of the transmitting station. Twenty or thirty turns of wire, spaced ⅛ inch, wound around the same frame will give good results on the longer wave lengths. For amateur reception, the coils are preferably mounted on the roof of the building and constructed so that it may be rotated through an arc of 180 degrees by some me-

chanical contrivance within the station. A four-stage resistance coupled amplifier constructed in accordance with the description in the April issue of THE WIRELESS AGE, or in accordance with the several circuits shown in the recently revised text book "Vacuum Tubes in Wireless Communication," will permit reception of short wave lengths over considerable distances. The directional characteristics of these frames permit a considerable amount of interference to be eliminated. Such an aerial, in fact, constitutes a direction finder and will indicate the general direction of an advancing wireless telegraph wave.

* * *

J. A., San Juan, Porto Rico:

Perhaps you misunderstood the reply to the query in the September, 1917, issue of THE WIRELESS AGE. Loading coils should be connected in both primary and secondary circuits of the long wave receiving tuner mentioned in that query. Unless multi-layered primary and secondary coils are used the tuner would be too clumsy to be manipulated conveniently.

The inductance required in the secondary circuit of a receiving tuner for a given wave length can be readily calculated by Nagaoka's formula, shape factor curves for which are given in the text book "Practical Wireless Telegraphy." To determine the required value of inductance you must first decide on the maximum shunt capacity to be used across the secondary circuit. Then use the following formula:

$$L = \frac{\lambda^2}{3552 \times C}$$

where C = capacity of the condenser in microfarads, λ = wave length in meters and L = inductance in centimeters. The dimensions of a coil to satisfy the inductance found by the above formula may be determined from Nagaoka's formula in "Practical Wireless Telegraphy" or Lorenz's formula in "How to Conduct a Radio Club."

In regard to the condenser of one microfarad capacity: You will find it less expensive to purchase one of this capacity than to construct it. Doubling the area of the surface of the condenser will double its capacity, provided the dielectric remains the same. Any electrical supply house can probably furnish you with one of these condensers.

Galvanized iron wire will function as a receiving antenna, but copper wire is better. Platinum wire can be obtained from any electrical supply house.

Regarding the dimensions of the buzzer coil for exciting the secondary circuit of the receiving tuner: If you desire to employ an aperiodic excitation circuit, a dozen turns of annunciator wire wound on a spool 2 inches in diameter, will be sufficient to set the detector circuit into excitation.

* * *

J. P. S., Buffalo, N. Y.:

If your first inquiry in reference to the best amateur antenna refers to wireless transmission at amateur wave lengths, the flat top portion should not be more than 120 feet in length; otherwise, the fundamental wave length will exceed 200 meters. A "T" aerial of the same dimensions as the "L" type will have a lower fundamental wave length. To change from an "L" to a "T" aerial often proves a very convenient means of reducing the fundamental wave length below 200 meters.

In reply to your second query, regarding the relation between the power of a transmitter and the radiated wave length: You should know that many variable factors enter the case. A high power transmitter necessarily radiates at long wave lengths on account of the large condenser required to absorb the output of the high voltage transformer.

In reply to the third query: When a wireless transmitter radiates waves of high decrement it radiates a wave of such characteristics that it will set into excitation receiving sets which are not sharply tuned to the radiated wave.

The Weagant static eliminator is feasible for amateur working but requires rather large aerials. Each loop should be about 350 feet long and the plane of the antennae should preferably point in the direction of the transmitting station.

* * *

J. W., New York City:

You are quite right in assuming that an undamped wave receiving set which employs the heterodyne principle radiates electromagnetic waves. If one of your amateur friends possesses a similar set there is no reason why you cannot establish wireless telephone communication over one-quarter mile, as you suggest. In fact, the writer, with an 8,000 meter set adjusted for undamped reception has communicated telephonically with another amateur station adjusted to the same wave length over a distance of 1¾ miles. You would obtain far better results with the circuit you have shown by connecting the microphone in some part of the grid circuit. Of course you cannot expect to obtain maximum efficiency in undamped wave transmission with a receiving set because of the resistance of the tuning coils.

In the matter of wireless telephony, your attention is directed to the last chapter of the newly revised edition of "Vacuum Tubes in Wireless Communication." Complete details of oscillating tube wireless telephone transmitters that will prove highly satisfactory for amateur communication are given. Also note the article by M. W. Sterns in this issue of The Wireless Age.

It is practical to connect several oscillating bulbs in parallel. Good results will be obtained with bulbs of identical operating characteristics.

The presence of a ground antenna within 40 feet of your receiving antenna will effect the latter's resonating qualities and change its wave length. Whether or not it will weaken the signal in the receiving antenna is a matter governed by many variable factors and the facts can best be determined by experiment.

The matter of amplification in vacuum tube circuits is an elusive measurement, from the amateur's standpoint. Just how much a set will amplify depends upon a number of conditions which have to be taken into consideration. One thing you will observe in a cascade amplifier is, that its amplifying qualities are most discernible in the reception of weak signals. Strong signals will not be much louder than with a single bulb.

* * *

H. H., Atlantic City, N. J.:

In view of the local conditions surrounding your station, it is believed that an antenna built in accordance with the sketch you have sent in is the best possible design. It is often very difficult to remove the induction from arc light circuits and trolley wires. One method of getting rid of this interference is to erect a single wire aerial 30 or 40 feet high in close inductive relation to the power wires and couple this circuit inductively to the secondary circuit of the receiving transformer. By this means, the the interfering currents in the receiving antenna can sometimes be brought into nearly opposite phase with those induced in the special antenna, resulting in almost complete annullment. The diagram you show for a receiving set is correct. Special advice on this matter is not necessary. The Wireless Age has published many diagrams applicable to amateur work.

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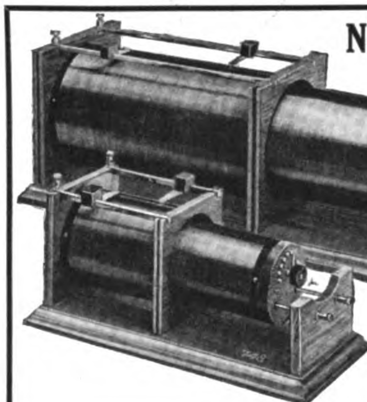

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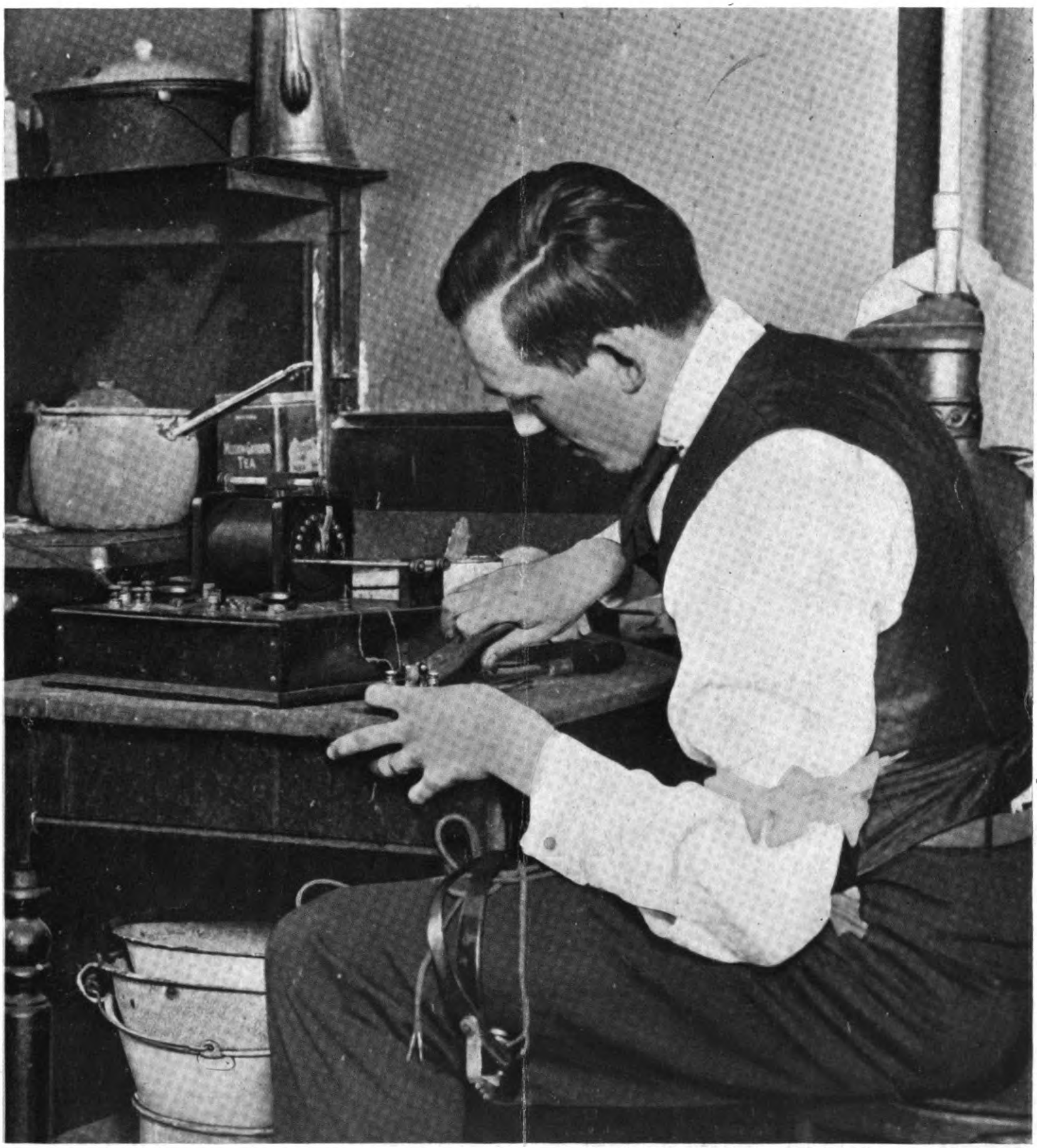
The WIRELESS AGE

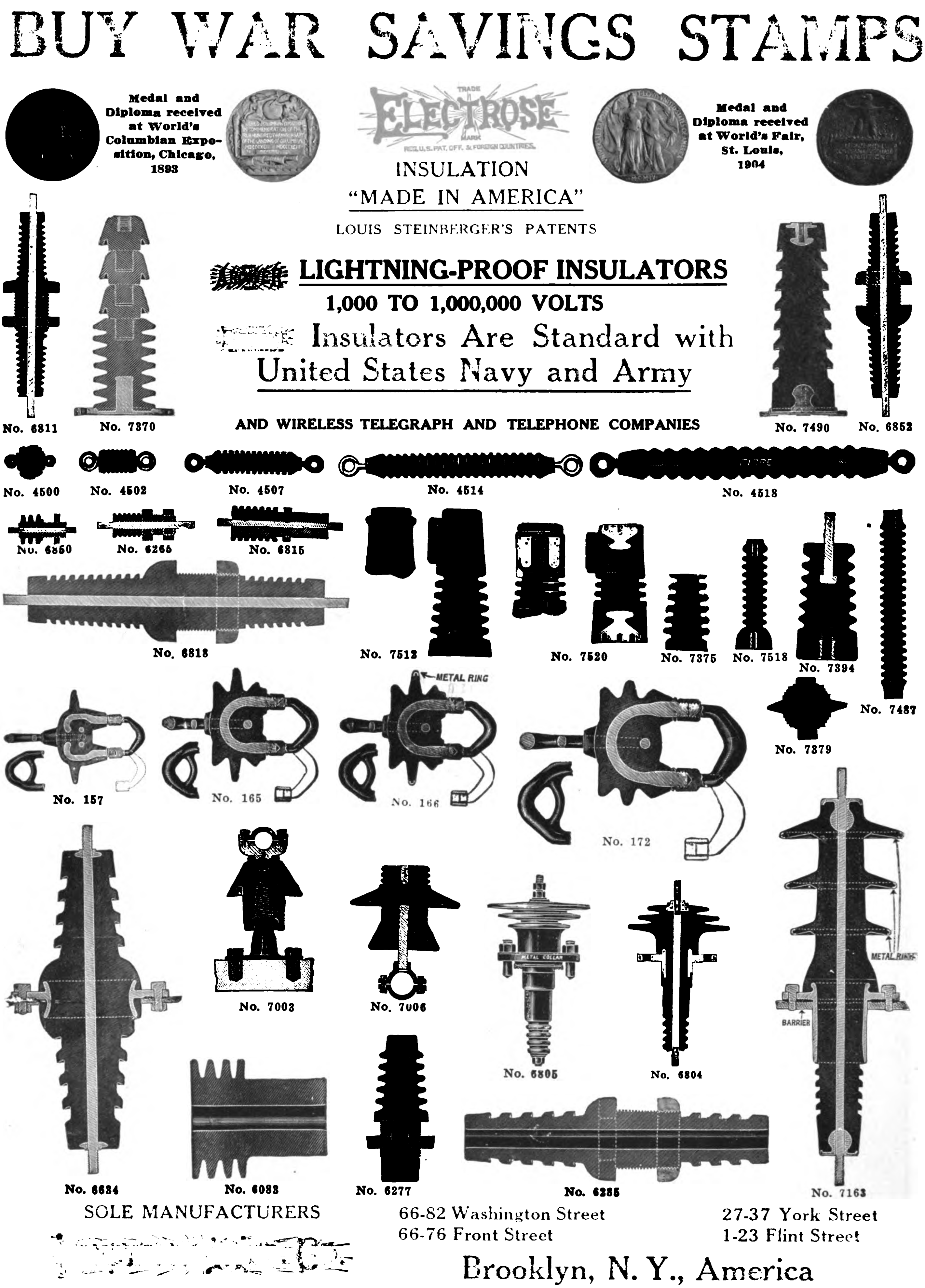
Volume 6

Number 10



The Amateur Gets Busy Again

Exclusive Description of the Greatest Invention of All: Weagant's Discovery Eliminating Static Interference


BUY WAR SAVINGS STAMPS
Medal and Diploma received at World's Columbian Exposition, Chicago, 1893
ELECTROSE
INSULATION
"MADE IN AMERICA"
LOUIS STEINBERGER'S PATENTS
LIGHTNING-PROOF INSULATORS
1,000 TO 1,000,000 VOLTS
Insulators Are Standard with
United States Navy and Army
AND WIRELESS TELEGRAPH AND TELEPHONE COMPANIES
Medal and Diploma received at World's Fair, St. Louis, 1904
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The Wireless Age

Edited by J. ANDREW WHITE E. E. BUCHER, Technical Editor

Vol. 6 No. 10

Contents for July, 1919

Index of Equipment

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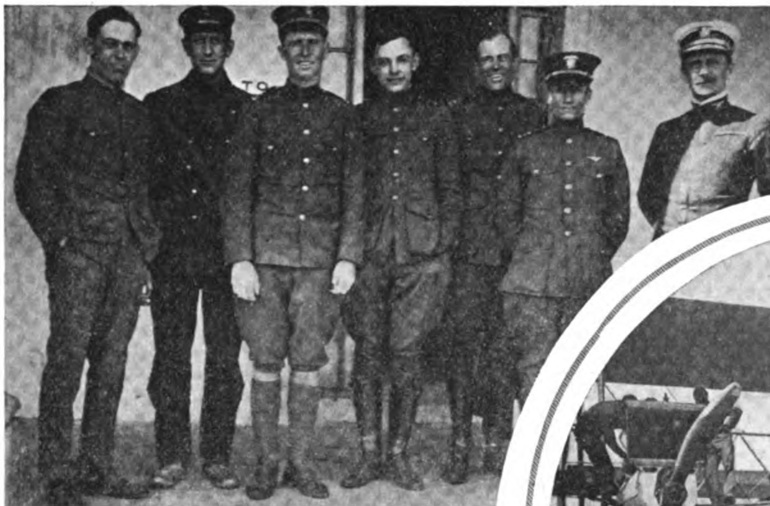
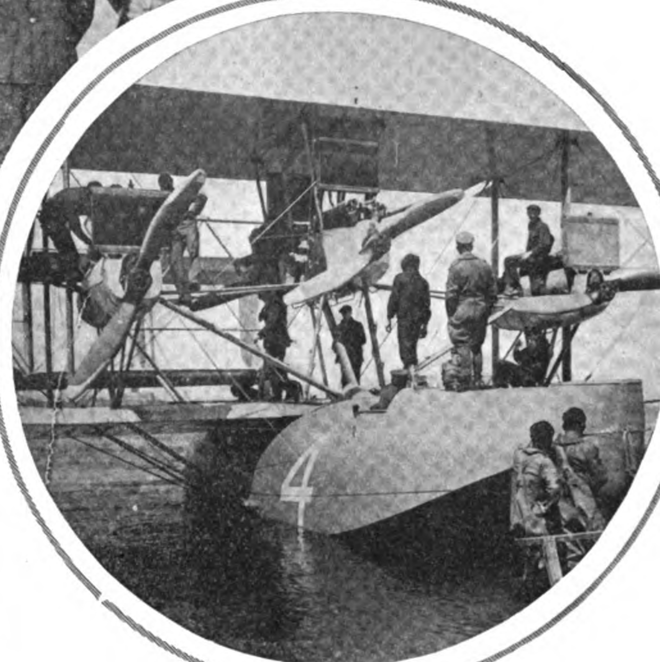
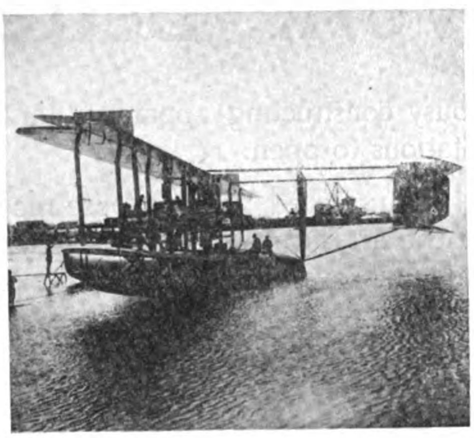
GREAT BRITAIN, Marconi House, Strand, London AUSTRALIA, 97 Clarence St., Sydney, N. S. W.

THE FLIGHT OF THE NC-4

Members of the pioneer cross-ocean air crew as they appeared when they landed at the Azores



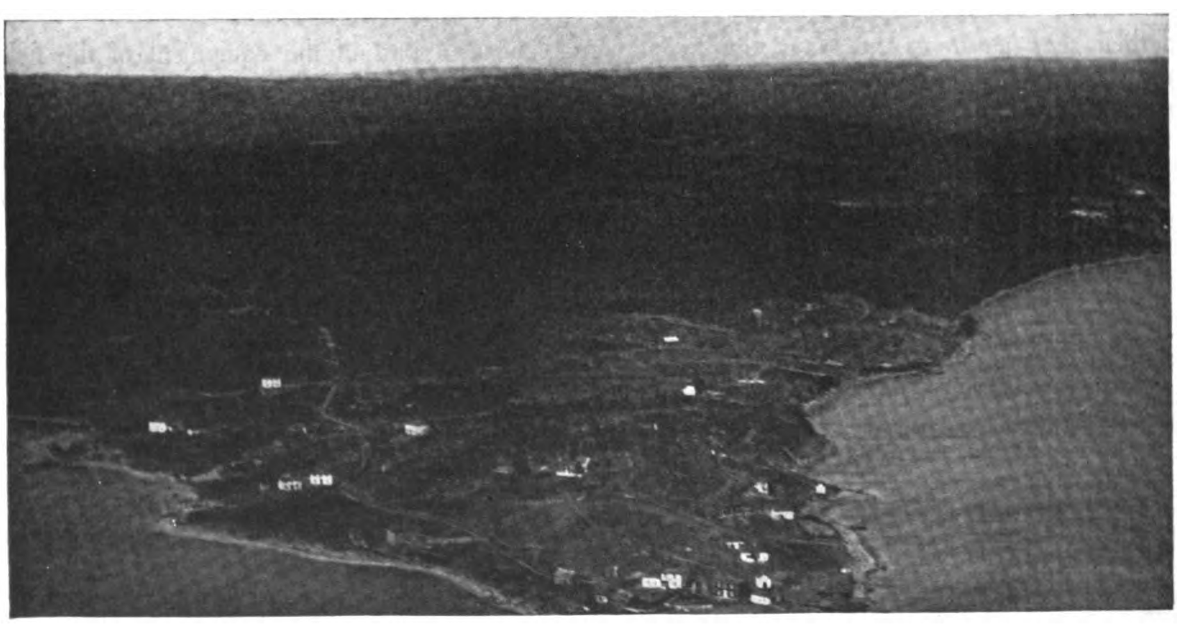




Above, in the circle, a view of the final preparations and inspection prior to making the first overseas flight in history

On the left, the NC-4 just before leaving Rockaway Beach for the trans-Atlantic "hop"

Press Ill. Svce.



As Trepassey Bay looked as the three naval flying boats headed off across the ocean

VOL. 6. No. 10. JULY, 1919

THE WIRELESS AGE

WORLD WIDE WIRELESS

Wireless Telephony at Atlantic City

DEMONSTRATIONS of wireless telephony as applied to airplane movements, were among the features of the work of the second Pan-American Aeronautic Congress held recently at Atlantic City.

Many visitors and delegates had their first actual experience with this adjunct to aviation through the apparatus which was installed at the ocean ends of the Steel pier and Young's million dollar pier, and which established and maintained easy communication by the speaking voice with a seaplane in full flight about twenty miles off the New Jersey coast.

As used in the seaplane the apparatus clearly demonstrated the remarkable progress that has been made in constructing complicated instruments in a compact yet accessible manner. Formerly a radio telegraph outfit for sending and receiving occupied a large space, was bulky and cumbersome. Now one small table holds all the needed devices for either telephoning or telegraphing through the air.

National Radio School for Navy

GREAT LAKES has been chosen by the Bureau of Navigation as the site for the new radio school which is to be founded at this station. The first real information came through Lieutenant Mason, district communication superintendent and temporarily in charge of the radio school.

Plans beyond the tentative stage have placed the personnel in the new school at five thousand and there are possibilities of it assuming larger proportions. Commander Weaver in charge of all naval radio work in the United States will take command of this largest and only school of its kind in this country.

The school will be the center of all naval radio telegraph and radio telephone instruction work. Officers are firm in their belief that it will be one of the greatest educational institutions that the navy ever has afforded.

Tribute Paid to Wireless Heroes

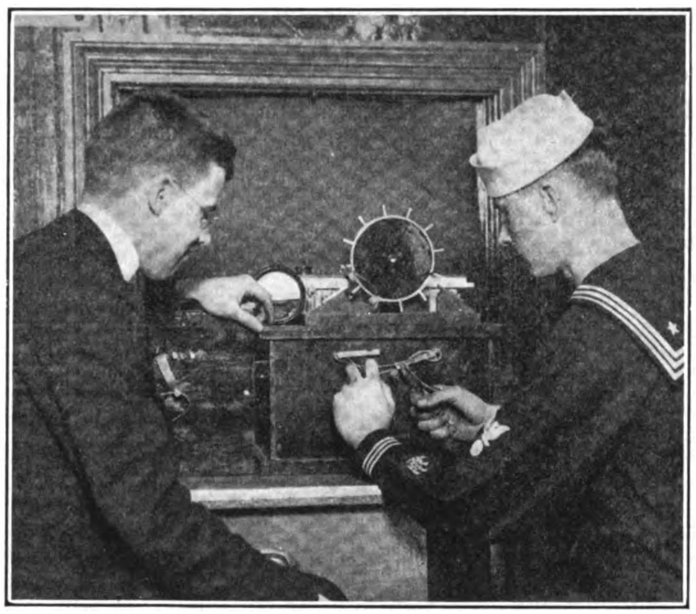
ON Memorial Day a wreath was placed on the monument erected in Battery Park, New York, in memory of wireless operators lost at sea. For the fourth successive year a committee of officials of the Marconi Wireless Telegraph Company of America visited the memorial fountain and with a simple ceremony paid tribute to the wireless men who have given their lives in the service of the merchant marine.

The monument was erected in 1915 by popular subscription during the time when the world was recovering from the shock of the Titanic tragedy.

Commercial Wireless Company for China

AN agreement has been signed between Marconi's Wireless Telegraph Company, Ltd., and the Chinese Government for the formation of the Chinese National Wireless Telegraph Company, with a capital of $3,500,000, half the amount to be subscribed by the Government and half by the Marconi company.

The Marconi company will manufacture wireless apparatus in China and also maintain existing and future wireless installations.



Press Ill. Svce.

A happy moment for the amateur for the naval man is breaking the seal of an amateur wireless apparatus silenced during the war

Wireless Aids Victim of Mysterious Shooting on Shipboard

IN answer to a wireless call from the steamship Makanda of the United States Shipping Board, lying off Sixty-fourth street, Brooklyn, Capt. John Smith of the police marine division responded in a police launch. He found John O'Donnell, 39, a fireman, suffering from a gunshot wound in the left arm.

O'Donnell said that when working on the deck he suddenly felt a stinging sensation and discovered that he had been wounded. He heard no gun report and said that the shot must have been fired from shore or from a passing vessel. He was treated and taken to Kings County Hospital.

Radio Service between Australia and Britain Under Consideration

A COMMERCIAL radio service between Australia and the British Isles is being considered by the Australian Government. It is estimated the cost of wireless transmission would be only one-third of cable messages. If the plan goes through, the cables still will carry the bulk of the code traffic.

The British War Cabinet has appointed a telegraphic communications commission, headed by Lord Milner, to consider the establishment of State-owned wireless stations throughout the Empire.

Wireless Telephone Discovered by Accident

THE wireless telephone was the accidental result of a search for something quite different—the wireless transmission of power. This was the opinion advanced at a recent meeting of the Institution of Radio Engineers in the Engineers' Building by E. F. W. Alexanderson, when accepting the gold medal of the institution in recognition of his original research and invention in the radio field.

"Radio telephony," he said, "is a by-product of the sustained radio waves as a method of alternating current power telegraphy to reproduce speech from the transmission. With the previous system of spark telegraphy it was no more possible to transmit the modulations of the human voice than it would be in land dots and dashes of the Morse code."

Marconi Company Wins Important Patent Litigation

IN a decree recently signed by Federal Judge Mayer, the Marconi Wireless Telegraph Company of America has again been successful in patent litigation under the Fleming Patent No. 803684 granted November 7, 1905 to Prof. John Ambrose Fleming of England, the famous Marconi wireless expert. This patent owned by the Marconi Company, covers the audion—known as one of the most sensitive instruments for use in wireless telegraphy and telephony—and the decree obtained by the Marconi Company is directed against the Atlantic Communication Company, which operated the high power wireless station at Sayville, Long Island, prior to the war in connection with German interests.

The Sayville station was built before the war and was finally taken over by the United States Government, so that no injunction could issue in this suit, but now the Federal Court has held that the receiving apparatus employing audions infringes the Marconi Company's Fleming patent and the decree excludes the Atlantic Communication Company from all rights in the invention.

The Court has appointed Judge E. Henry Lacombe, a special master to ascertain the amount of damages to be assessed against the defendant company, the assets of which are all in the hands of the Government.

International Company Begins Radio Phone Suit

A PATENT infringement suit has been started in the Federal District Court by the International Radio Company of Wilmington, Del., against the Western Electric Company of New York. The complaint alleges that the International Company owns six patents granted to Reginald A. Fessenden and that the apparatus covered by the patents is being used by the Western Electric in making radio-telephones which are being sold to the Government.

The plaintiff asks for triple damages if the defendant continues to manufacture and market the telephones.

The Armistice Preliminaries Hastened Through Use of Wireless

WHEN the Huns last fall somewhat feverishly indicated the desirability of cessation of hostilities it was the judicious use of wireless by Uncle Sam, in direct communication with the enemy on his own stamping-grounds which hastened the armistice preliminaries and brought the fighting to an end Nov. 11. It wasn't exactly according to Hoyle. In fact, communicating in such a forthwith and extemporaneous manner in that sort of situation "isn't done" in well-regulated diplomatic circles, or it hadn't been until your Uncle Samuel did it.

The story of how it was done was told in the New York Evening Post.

It was 12 o'clock noon—one day about Oct. 20, last—when every government wireless operator on duty in the allied countries was startled out of his wits by a signal-call from the radio-station at New Brunswick, N. J. The operators of the wireless stations of the central powers could not have been more surprised.

"P O Z—P O Z—P O Z—de N F F," buzzed the wireless. The allied radio operators saw immediately visions of brazen treachery or equally brazen German spy operations in the United States. They saw visions of an American war-scandal, such as the world had never known, court-martials and firing squads and possible revolution in America.

For P O Z is the radio call for the German government wireless station of Nauen, a suburb of Berlin, and N F F is the radio address of the United States naval sending station at New Brunswick, and the two had not been on speaking terms for a long time.

There must have been a real Prussian at the Nauen switchboard, for within two or three minutes, he responded patronizingly: "Your signals are fine, old man."

Whereupon the "old man" in New Brunswick proceeded to dispatch through ether a message which was not so fine as it was clear. No code was used. The message was in plain English. It was the first of President Wilson's statements to the German people carrying the suggestion that the allies would conduct no negotiations for an armistice and peace with the German government as then constituted.

Thereafter Washington was in constant communication with Berlin. Wireless was making history at a faster pace than all the engines of destruction on the battlefronts had ever been able to set up. Wireless was saving thousands of lives, perhaps millions. The negotiations between Washington and Berlin continued till the day the armistice was signed.

Japanese Ships Have New Wireless 'Phones

TOKIO papers state that wireless telephones are to be installed on the Toyo Kisen Kaisha passenger liners operating across the Pacific from San Francisco to Yokohama.

The department of communication of Japan, it is stated, is completing arrangements to connect the steamers at sea with public telephone centrals at Tokio and Yokohama by means of wireless telephone apparatus.

New York Manufacturer to Use Wireless

A PROMINENT electrical and radio manufacturing concern of New York City will install, as soon as the ban on sending is lifted, a complete Radio Telephone System between their factory and several branch stores, so as to relieve a greater portion of the land telephone traffic between these units of the organization.

Speed Record Made in Broadcasting Wireless Communication

THE navy in its effort to establish a world's record with a flight across the Atlantic, also set up a new mark in wireless communication.

With the seaplane NC-4 zipping up the North Atlantic coast to join its fellow fliers in cross-sea flight, Acting Secretary Roosevelt grew anxious as to Commander Read's progress. A wireless telegraph message to the NC-4 was transmitted as follows:

"What is your position? All keenly interested in your progress.

"ROOSEVELT."

Two minutes later the radio operator took the following reply by wireless telephone from Commander Read of the NC-4 on the desk at the Navy Department:

"Roosevelt, Washington. Thank you for good wishes. NC-4 is twenty miles southwest Seal Island, making eighty-five miles per hour.

"READ."

In three minutes the high power wireless stations had flashed the news to Paris, London, Panama, San Diego, Cal., and all ships at sea.

Fort Cliff Wireless Compass Station Burns

THE Coast Guard and Radio Compass Station at Fort Cliff, Mass., has been destroyed by fire together with practically all of the life saving apparatus except a small surf boat. Members of the crew escaped by jumping from second story windows. The station was in charge of Capt. Matthew Hoar.

Wireless Messages Received Inside Steel-Concrete Vault

A WIRELESS telephone message from the station at New Brunswick, N. J., has been received at Asbury Park inside a steel and concrete vault under-ground by W. Harold Warren of New Brunswick. He had a portable receiving set, carried in one hand, and neither aerial nor ground connection.

Two sets of head receivers were used; a wireless telephone speech from the New Brunswick radio station was heard distinctly.

The main dining room of the Hotel Klein, New Brunswick, was connected with the local radio station by regular telephone and a relay connection made by wireless telephone. The music of the hotel's orchestra was clearly heard by Mr. Warren inside the vault at Asbury Park.

The commandant of the naval station said that on the last trip of the steamer George Washington to France with President Wilson, the orchestra of the hotel was connected by wireless telephone with the vessel and the music was clearly heard when the ship was 600 miles at sea.

Canadian Forest Fires Fought by Wireless Telephone

CANADA is employing the wireless telephone and airplane in forest-protection service. Two machines have been installed in the Quebec district, and they operate in conjunction with patrol stations, with which the machines are in communication by wireless telephone. Such a system assures prompt discovery of forest fires and early effort at extinguishing the blaze may result in saving great quantities of valuable timber.

New Transatlantic Station at Montreal

THE Marconi Company will erect a long distance wireless station at Montreal to handle some of its transatlantic business. The station will work directly with Paris according to the announcement.

A fine aerial for a hot summer day when signals are coming in bad

Audio Frequency Signals for Aviators' Use in Fog

THE Navy Department has adopted an audio frequency signal for aviators which will enable them to land with safety in a dense fog or in the dark.

This system of audio transmission which has been perfected has played a conspicuous part in the war and is now being applied to the uses of peace. It will be of advantage to navigators finding their way through fog into port, as well as to navigators in the air.

The difficulties encountered because of fog in the recent transatlantic flights of the NC-4's and the Vickers-Vimy airplane demonstrates the need of just such a device.

Mobile Station Gets Two New Towers

TWO new towers for the wireless station of the former Marconi station at Mobile, Ala., on top of the Battle House are being erected. This station is under the direction of the government at the present time. The towers were blown down in the storm of July 5, 1916, and were never restored except in a small way. The towers will be about 40 feet in height.

Nauen and Eiffel Tower Communication Resumed

WIRELESS communication between Nauen and the Eiffel Tower in Paris has been resumed so that the German peace delegation can keep in close touch with Berlin.

British wireless men of the 11th Corps stationed at Weisdorf, Cologne. The building in the background is a part of the great German chemical works at Weisdorf

Two Laymen's Views on Radio

If wireless is going to be the means of communication in the future, why have any argument over the German cables?—*Buffalo Commercial.*

Now that the wireless telephone between America and Europe has been established successfully, one would love to hear what Richard Strauss is saying at being ousted from his conductorship and directorship of the Berlin (no longer Royal) Opera.—*Philadelphia Record.*

Wireless Outfit on Roof of Flying Club in New York

THE American Flying Club, 11 East Thirty-eighth street, New York, has now a radio outfit with which the members hope to keep in touch with aircraft flights at a great distance.

Advantages pointed out at the clubhouse are that the club will be able to promote public interest in the operations of aircraft by disseminating such information as may be received. The members, most of whom served as pilots in the European war, feel generally that it will be a help to their craft in many ways if they can educate the public regarding it. They believe that at present too little is known about the doings of the fliers.

Recently, it was stated at the clubhouse, many flying clubs of other cities have written to this organization suggesting affiliation.

The club's president is Lawrence L. Driggs and its honorary president Gen. Charles T. Menoher, head of the army air service. Many noted air fighters are among the members. It has no connection with any other organization.

Americans Ably Assist a German Station in Africa

AS late as the middle of January a German wireless station was operating in Africa. How this station was discovered and the amusing incident which accompanied the discovery is reported by Gordon Stiles, Chicago News correspondent. It appears that the officers of one of the giant radio plants conducted by the American army of occupation had their suspicions aroused by the nature of the messages which were being sent out from the Nauen tower near Berlin, and after a long investigation they came to the conclusion that the German government was communicating with some foreign station.

Working on that theory, they finally discovered that in the mass of news and propaganda emanating from Nauen was a code. Further, it developed that these code messages were addressed to a station in Africa. Once the Americans had worked out the code it was easy to decipher the messages, which really were harmless, but the German government had been steeped in intrigue for so long that it was second nature to go the longest way around if there was an element of secrecy in such a course.

At any rate, having the messages in their possession, the American wireless men sat down to await the reply. This came in due course and was easily received by the American operators. Not so with the Nauen tower. It seems that the waves were very weak and also that the German amplifiers have been surpassed by those of the American radio service. The result was that the Germans never received the message.

The officer in charge of the American station is a bit of a wag. He held up the message three days and then sent it through in perfectly good German to the Nauen tower, adding, "So sorry, old man, your amplifiers are not up to the Yankee ones," and the Nauen tower operator was a good enough sport to acknowledge the message. Nothing has been heard of the African station since.

New England's Compass Stations Installed

ONE of the most helpful uses of wireless has been inaugurated in the radio compass stations now being installed at harbor entrances and at dangerous headlands around the New England coast. On the Rhode Island shore, there is one at Prices Neck and another is under construction at Watch Hill. The arrangement enables a vessel, by wireless communication with the stations to get its compass bearings with respect to the coast, or find out its position at sea. The stations will furnish positions to ships within thirty miles of the entrance to the outer channel of a harbor, and bearings to within one hundred miles.

Within the radius of the operation of these stations there should be no repetition of such miscalculation as resulted in the stranding of one of our transports from Europe on Fire Island, while feeling its way in a fog toward New York. There are various methods of finding the position of a ship on approaching land, but only one, taking soundings, is available in weather thick enough to shut out the shore line; and the lead is of little use until the ship is in dangerous proximity to the land. In the case of the stranded transport the navigating officer had been tracing his course by dead reckoning, after some days of fog. Had he been able to call a compass station he could have obtained his position and true bearings as soon as he approached the New England coast, and been guided safely to New York by repeated communications. For ships on the sea not looking for a harbor entrance, the service should prove equally valuable where the latitude and longtitude have become uncertain owing to encounters with storm or fog.

Weagant's Anti-Static Invention

Details of a Great Discovery That Has Revolutionized Long Distance Wireless Communication*

An abstract of a paper read before a joint meeting of the New York Electrical Society and the Institute of Radio Engineers at a monthly meeting, Wednesday, March 5th, 1919.

Part II

Reported by Elmer E. Bucher

Director of Instruction, Marconi Institute

IT was mentioned in the preceding article that Mr. Weagant observed the necessity for local tuning of each loop in all arrangements employing two widely separated closed circuit loops or cages connected to a central receiving station by long low horizontal leads. This required placing an operator at each cage and informing him by telephone just what adjustments were to be made in order to change the wave length or to obtain a good static balance. Obviously, this was not a convenient arrangement, and an added objection previously mentioned, was that the long, low horizontal leads acted as aerials, picking up both static and signals. Although this particular structure gave a marked reduction in static currents while retaining useful amounts of the signal currents, it cannot be said to have fully satisfied the requirements of modern radio engineering and commercial practice.

In an effort to overcome the troubles incident to the use of the loops with long low leads, Mr. Weagant and Mr. Waterman, jointly, conceived the idea of making the loop and lead-in wires, one; and accordingly experiments were conducted with two loops, each of which consisted of a single turn of wire extending out from the station and back again. This arrangement was free from points where abrupt changes in the circuit constants took place, which was not the case with the cage aerials which made use of the long horizontal leads.

A particular form of the Weagant-Waterman antennae is shown diagrammatically in figure 18. In figures 19 to 33 other structures are illustrated, showing experimental steps with various loops consisting of a plurality of turns, or single turns with different spacings and other modifications. In the practical installation of the system of figure 18 at Lakewood, N. J., in the spring of 1918, the spacing between the upper and lower wires was 15 feet. The poles were 30 feet high and each loop was about three miles in length.

One of the first discoveries made in connection with the enlarged single-turn loops, was that they could not be tuned to sharp resonance with any particular incoming frequency; in fact, the insertion of inductances and capacities in the loops to establish resonance at different wave lengths had seemingly no effect upon their frequency of oscillation.

It was believed that this result was due to a current distribution in the loops of such a nature that a current node existed at the point of insertion of the tuning devices. This distribution was successfully altered by the insertion of inductances at suitable points. A coil of 30 millihenries was inserted, successively, in the upper wire at points between the receiving station and the other end of the loop; it was found that the tuning improved constantly as the coil was moved from one end toward the middle, but it became poorer as the coil was moved from the middle toward the end.

It is interesting also to note that when an inductance was inserted in the lower wire it produced no result. When coils were inserted in the middle points of both lower and upper wire at the same time, the effect of the latter was annulled. Experiments showed that 30 millihenries was about right for a wave length of 12,000 meters and 5 millihenries for 6,000 meters, but either value was sufficiently acceptable for both wave lengths, with loops each three miles long.

After this definite method of tuning had been determined, the results secured in balancing out static and retaining the signal were most satisfactory. The over-all results obtained were better than those secured with smaller loops spaced far apart and connected to the receiving apparatus with long low horizontal lead wires, because in that arrangement the leads had acted as aerials and reduced the effective spacing of the two end loops or cages. The most effective spacing of two such loops was found to be one-half wave length between the centers, which is in agreement with the theory previously outlined.

Special Forms of the Weagant Antennae

An exhaustive series of experiments with enlarged loops of various types were carried on at Lakewood, N. J. Various modifications such as shown in figures 19 to 33 were put under observation. In most of these drawings, the antenna structures are self-explanatory. All those used were found effective in eliminating static interference.

It was believed that the construction shown in figure 31 would give greater effective wave length separation if the receiving aerial extracted energy from passing electromagnetic waves in accordance with the usually accepted theory. But the experiment proved quite conclusively that the loops did not behave in accordance with this assumption and, as Mr. Weagant stated, his whole work has demonstrated that existing ideas of the mechanism by which the loop aerial extracts energy from a passing electromagnetic wave will have to be considerably modified.

In explanation of the special constructions shown in figures 19 to 33: In figure 19 the two ends of the loop are left open at point 3. This arrangement was found to operate quite as effectively as when the circuit was closed. In figure 30, the loops are closed at the ends 4 by variable condensers. In figure 21, the loops are open at the upper conductors 6. Figures 22 and 23 show loops with different spacings between wires, figure 23 particularly showing the loops supported a greater distance above the earth than in the preceding figures. Figures 24 to 29 show loops containing a plurality of turns, while in figures 30 to 33 forms of loops having graded constants are indicated. In the circuit shown in figure 24, the localized inductance 15 is included in the construction of the loop itself; it may be located at any desired point in the length. In all these arrangements the lead-in wires extending from the end of the loops nearest the receiving

* Several of the drawings included in this abstract were not disclosed at the Institute meeting. Special permission to publish them in the Wireless Age has been granted by Mr. Weagant.

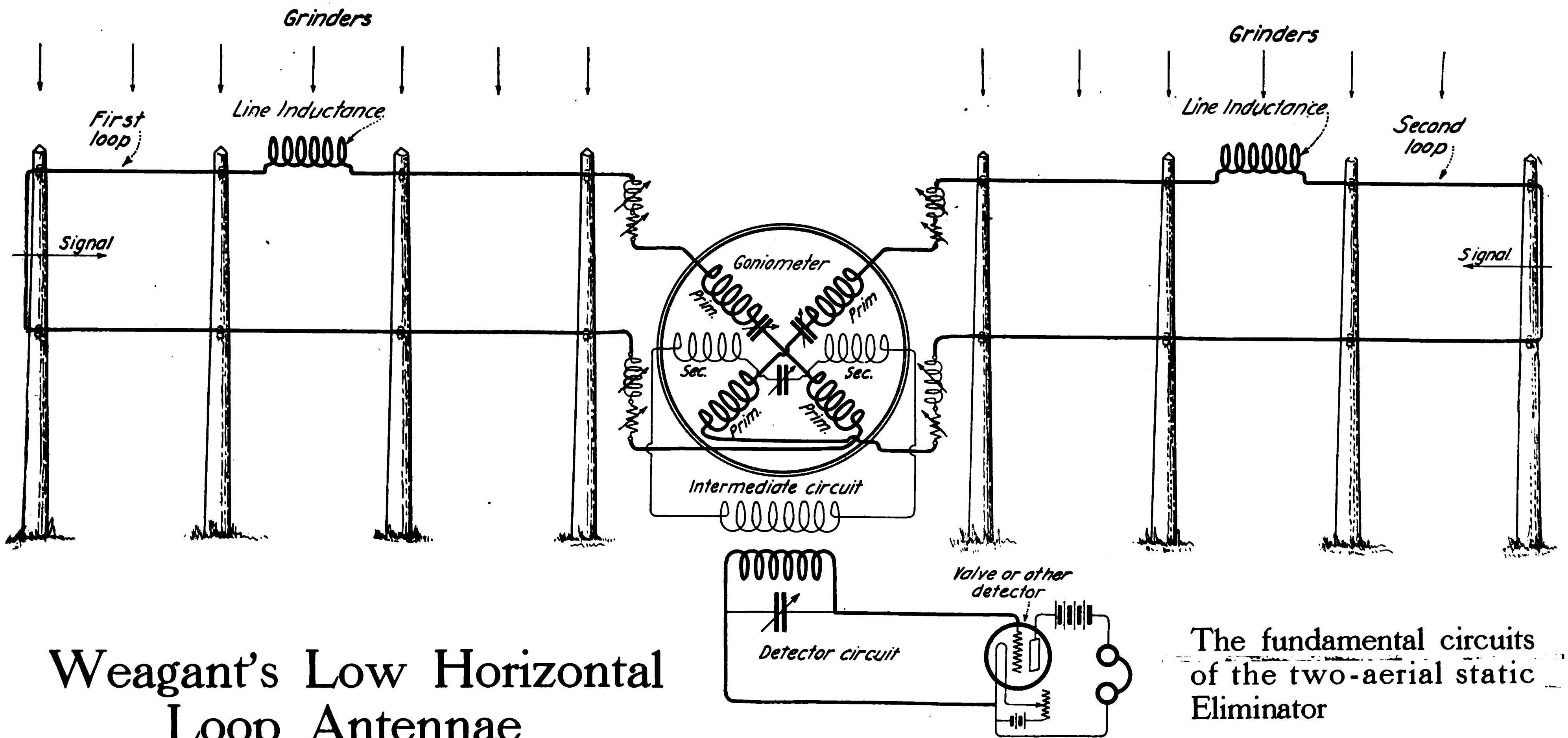


Figure 18

Weagant's Low Horizontal Loop Antennae

The fundamental circuits of the two-aerial static Eliminator

This diagram shows the fundamental circuits of the two-aerial Weagant system permitting continuous reception of long distance wireless telegraph signals through "static" interference which ordinarily would render the wireless signals unintelligible.

Mr. Weagant, having discovered that the dominant type of static termed "grinders," is apparently propagated vertically in respect to the earth, made use of the two loop antennae as here shown, to balance out static currents, while retaining the signal currents. In practice, the antennae are spaced any distance from center to center, the most efficient separation being one-half wave length. The terminals of both loops are connected to the two primary coils of a radio goniometer. The secondary coil of the goniometer is connected to a detector circuit which, in this diagram, includes a three-electrode vacuum tube. Appropriate loading inductances and variable resistances are connected in series with the leads of each loop to obtain the desired operating characteristic. A line inductance is inserted at the center point in series with the upper wire of each loop. Since the vertically propagated static waves act upon both loops simultaneously, the resulting E.M.F.'s are in phase and may be made to neutralize in the goniometer. Wireless signals on the other hand advancing either from the right or from the left, strike the two aerials at different times and the resulting currents are out of phase and their E.M.F.'s combine vectorially; that is, at any particular instant, the static currents and the signal currents in one loop flow in the same direction and in the other loop in opposite directions. Since the goniometer coils are coupled to the detector circuit in such a way that the static currents oppose and neutralize, the signal currents add their E.M.F.'s according to the effective separation of the loops. Experiments have been made with loops of various lengths up to three miles each, that is, with a complete antenna system six miles in length. In every case, it was possible to balance out the static currents and retain a useful amount of the signaling currents, thus proving Weagant's theory that static waves act perpendicularly in respect to the earth. This discovery represents the greatest progress in the art of radio communication since Marconi's original disclosures.

Not only does the Weagant system permit continuous reception through the severest types of static interference, but it has done away with the necessity for high towers, allows great distances to be covered with less power at the transmitting station and for the first time makes possible the use of an automatic recorder.

station are passed into the receiving apparatus through metallic covered cable.

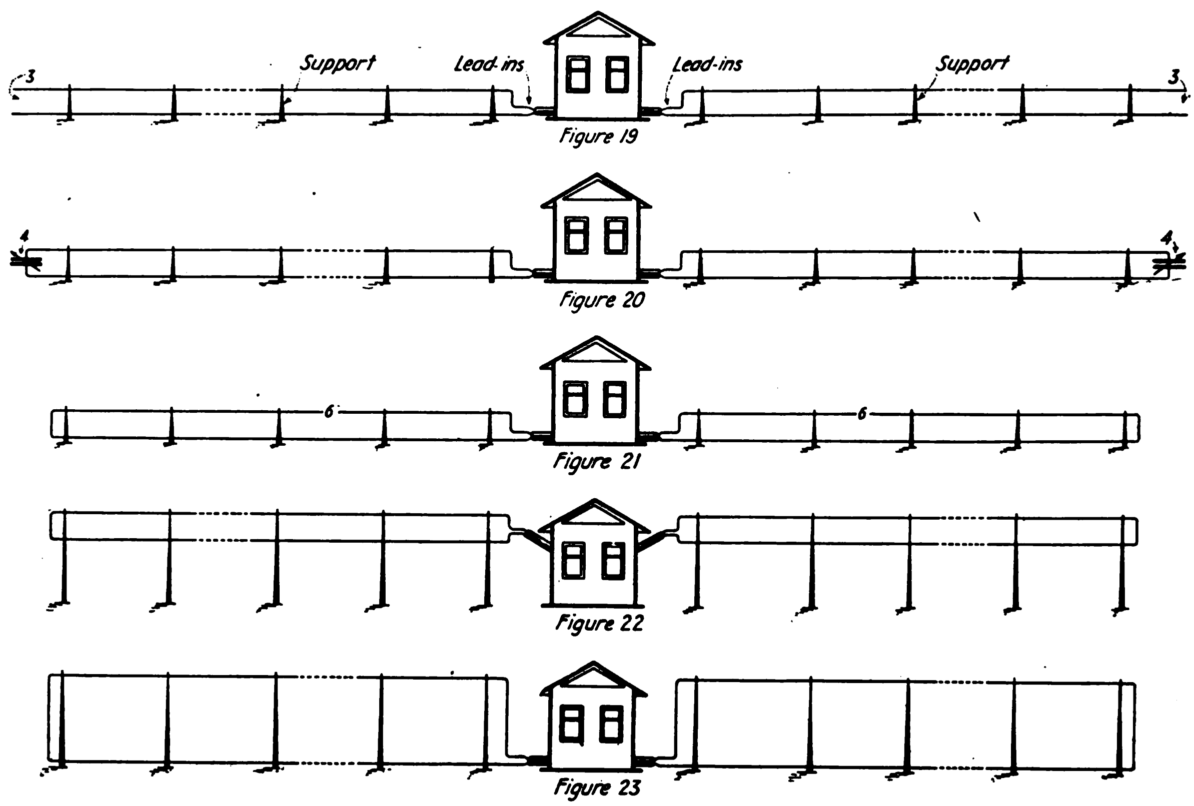
Practical Circuits

Detailed working circuits of the Weagant two aerial system for static elimination may now prove of interest. Figure 34 shows more fully the station house circuits disclosed fundamentally in figure 18, with the exception that the centrally located line inductances are not shown. Loading coils L-6 and L-7 are inserted in the lower lead of each loop and reversing switches S-1 and S-2 are placed between the loops and stationary goniometer coils, to obtain the most effective working. Variable condensers C-1, C-2 and C-3 are inserted in the center of each goniometer coil. Another reversing switch S-3 is placed in the intermediate tuning circuit which includes the rotating coil of the goniometer L-3, the load inductance L-4 and the coupling coil L-5 acting upon L-6 which in turn actuates the oscillation detector V-3.

series tuning, the single blade switches S-5 and S-6 are opened, S-3 and S-4 being closed to the top set of contacts. For parallel tuning, S-5 and S-6 are closed, S-3 and S-4 being closed to the bottom set of contacts.

Loading inductances L-11, L-12, L-13 and L-14 are placed between the leads and the goniometer coils so that either one or two loadings may be cut in each loop. The reversing switch S-7 permits the most favorable connection to the detector circuits to establish a satisfactory static balance.

In all of the foregoing arrangements, the general procedure to balance out static and retain the signal is, in brief, as follows: The rotary coil of the goniometer is placed in inductive relation to one of the two loops; the circuits are then tuned until the maximum signal strength is obtained. A similar procedure is carried out in respect to the other loop. Both loops are then connected to the goniometer and the third coil is rotated to a position giv-



Figures 19 to 23—Various forms of the Weagant antennae system utilizing two single turn loops separated at an appreciable fraction of a wave length

This particular diagram shows an oscillating vacuum tube, the plate circuit being shunted by an inductance and capacity in series, but any type of detector and circuit suitable for damped or undamped wave reception may be employed.

Because the variable condensers are connected in series with the stationary goniometer coils, the circuit of figure 34 is said to employ *series* tuning in contrast to figure 35 where the same condensers are connected in *parallel* with the stationary coils. The diagram, figure 36, on the other hand, includes a set of switches which permit either *series or parallel* tuning, at the will of the operator.

In the improved circuit, figure 35, line inductances L-9 and L-10 are inserted at approximately the center of the upper wire of each loop, the lower wire of each loop containing the loading coils L-6 and L-7. In the universal circuit for the two aerial arrangement shown in figure 36, S-1 and S-2 are reversing switches inserted between the leads and the goniometer; S-3 and S-4 permit the variable condensers C-1 and C-2 to be placed in series or in parallel with the stationary goniometer coils. For

ing maximum signals and minimum static. A finer balance is then obtained by adjusting the inductance, capacity and resistance in both loops.

One particular modification of the Weagant system for the elimination of static is shown in figure 36-A, a circuit which was employed in very early experiments at Belmar, N. J. Fundamentally, it consists of a loop antenna A-1, grounded to earth through the tuning inductance L-1 and the variable condenser C-1. The coil L-1 acts inductively on the secondary coil L-3, the terminals of which are extended to a detecting circuit as usual. A closed circuit loop A-2 of the early type, with long low horizontal leads was connected to the coil L-2 with the variable condenser C-3 in series; this coil also acts inductively on the secondary L-3.

It was possible with this arrangement to take advantage of the relative flow of currents and the inherent differences of phase between the currents in the grounded antenna and in the closed circuit loop, to balance out static currents and retain the signal currents.

Commenting upon the results obtained with the two

aerial system as installed at the Lakewood, N. J., station, Mr. Weagant said:

"This station was operated continuously from the middle of July until the end of September with a force of three operators, each working eight hours, copying messages sent out by Lyons, Carnarvon, and Nauen, regularly, and occasionally other stations. This continued operation was undertaken to determine the capabilities of the system in a practical, commercial way, during the worst period of the summer and at all hours of the day. The results secured were most gratifying, the total interruptions experienced being of no greater total duration than those of good cable working between the same points and at the same time of year.

"It was found that when the signal from the European fact that when the signal weakened greatly the click type of static was present in sufficient quantities to cause the trouble, and that when the signal intensity was greatly amplified in order to be heard, the amplification also brought up this disturbance with its ratio to the signal unaltered."

Continued experimenting eventually culminated in the perfection of a three aerial system which eliminated most effectively both the grinders and the click type of static and moreover gave signals of sufficient audibility for continuous reception from European stations of a much lower power than required to give response with the two aerial arrangement. The three aerial arrangement permitted reception through the worst fading periods without interruption.

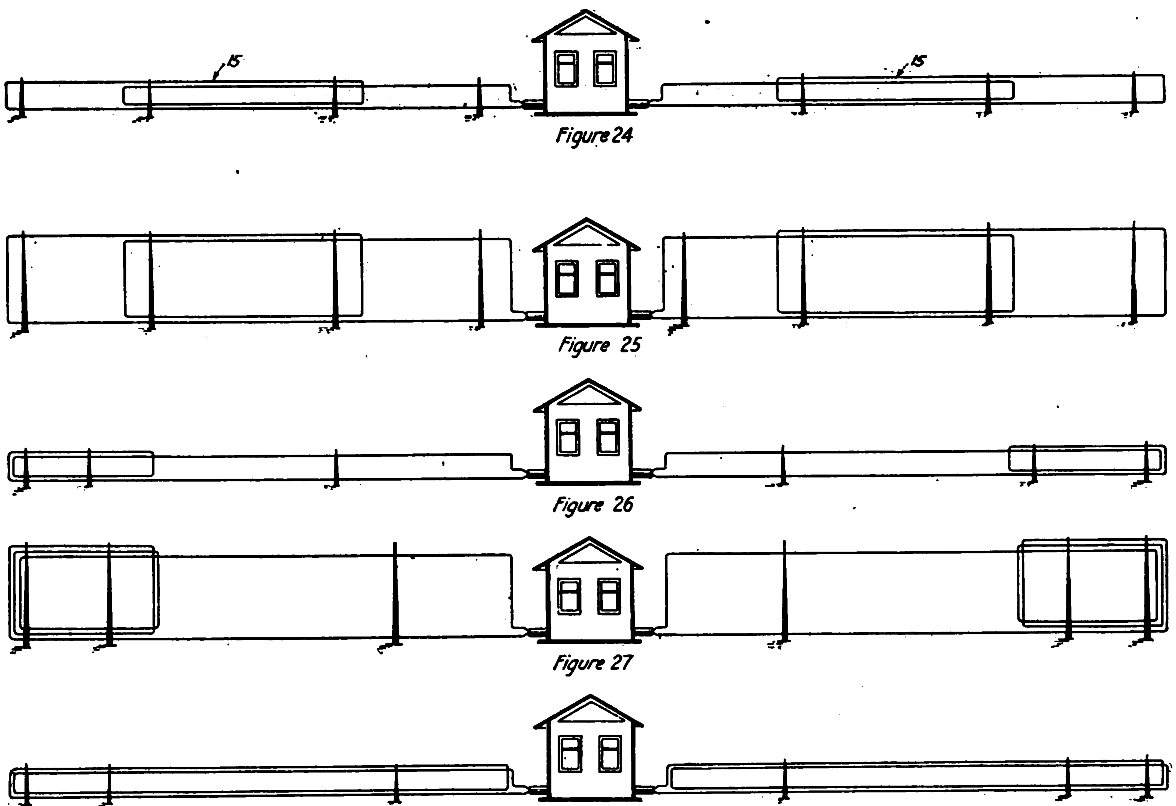


Figure 24

Figure 25

Figure 26

Figure 27

Figure 28

Figures 24 to 28—Loop aerials of the Weagant system containing either a plurality of turns throughout their length or through a part of their length. Various spacings between the upper and lower wires and between the wires and the earth are indicated

stations was of normal intensity the heaviest static experienced at any time was unable to interfere in the slightest, but that on the contrary, it might have been very much more severe without causing trouble. Reception under this condition was almost invariably good enough for high speed automatic reception.

"A few thunderstorms occurred during this time and some, but not all of them, prevented reception while they lasted. There were also periods recurring regularly every day between four and six o'clock in the afternoon and between twelve and two o'clock in the morning when the intensity of the received signals from Carnarvon and Nauen fell off enormously, on some occasions falling as low as 1/100th of their normal intensity. During a few of these fading periods, interruptions were experienced varying from five to ten minutes, to perhaps one hour. The worst of these periods was usually—but not always—the midnight to two a.m. period when, although the static was generally lighter than during the afternoon fading period, at which time its maximum intensity occurred, the decrease of signal strength was rather greater. A careful study of the conditions during these fading periods, convinced me that the difficulty was due to the

Characteristics of Static

In support of his theory which classified "grinders" as a type of static which is propagated vertically, and the "clicks", a type which is propagated horizontally, Mr. Weagant declared that continuous experimenting had established beyond doubt that the characteristics of the two prevailing types of static were well defined. The "grinders" are most prevalent in the warm season, between the noon hours and sunrise of the following morning.

Grinders generally produce in the telephone a continuous rattle, with occasional heavier crashes. This type of static seems to be vertically propagated and certainly affects aerials separated by considerable distances simultaneously. The two aerial system effectually excludes the grinders. The click type, however, which is apparently propagated horizontally, had to be dealt with in another manner.

Defining the clicks, Mr. Weagant said they are widely spaced crashes and are most noticeable during the cooler periods of the year and day. They do not interfere, except on rare occasions, with signals equal to the normal strength of Carnarvon, Nauen, or Lyons, but during

reception from stations of smaller power, such as Clifden, Ireland and Eiffel Tower, Paris, the clicks caused marked interference with the two aerial arrangement, and any adjustments that reduced the click type of static reduced the signal also.

By applying a principle hitherto unknown in radio engineering, both clicks and grinders were eliminated while the full signal strength of foreign stations was retained. A description of the three aerial arrangement follows.

THE STATIC TANK

Since the two loop aerial system had not as yet shown itself capable of sufficiently differentiating between the horizontally moving type of static and the signal so as to permit reception during the severest periods of signal fading, Mr. Weagant carried on a series of scientific investigations with a three aerial arrangement in which the two loops of the previous system were used as a "static tank." This system made possible the reception of signals from European stations of a much lower order of power than that employed by Carnarvon or Nauen. Although many times during the summer attempts were made to copy Eiffel Tower, France, on 8000 meters, with the two aerial arrangement, satisfactory signals were obtained only during the time when the "grinders" type of static predominated. When the "click" type of static occurred these stations could not be read. As a proof of the utility of the three aerial system a particular test was made through static disturbances of such intensity that the signals from Eiffel Tower were much below normal. It was barely possible to determine the presence of signal with the two aerial arrangement, but with the three aerial arrangement the signal was not only readable, but was of such intensity that it could be read with the telephones removed from the ear.

Before going into the details of the static tank, it may be well to define it briefly. *The static tank may be characterized as a source of static currents of both the click and grinders type of variable frequency, but not a source of wireless telegraph signals.* Hence, static currents can be withdrawn from the static tank to balance out the static currents in a third receiving aerial associated with the system (which picks up both static and signals) retaining only the signal currents. As will appear further on, several modifications of the static tank are possible, but the one about to be described has proved very effective, and from a commercial viewpoint is thoroughly practical for 24 hour transoceanic reception.

Referring now to the diagram, figure 37, it will be observed that two closed circuit loop antennae, each of which are 3 miles long (for the longer wave lengths) are mounted on short poles and connected to the primary coils of a goniometer located at a central point of the antenna system. As usual, the detecting circuit is coupled to an intermediate circuit which embraces the rotating coil of the goniometer.

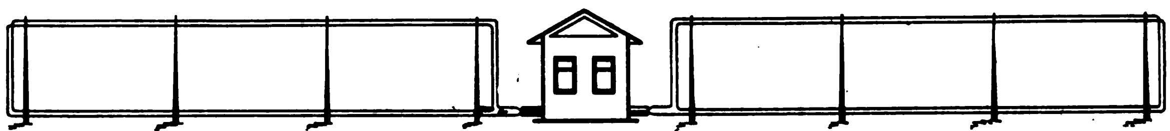


Figure 29

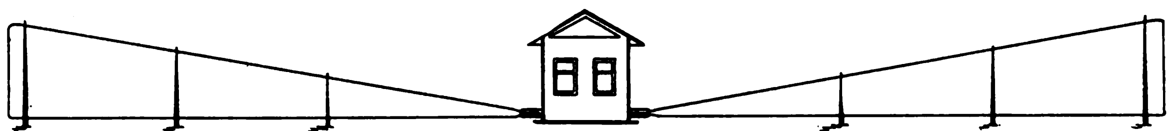


Figure 30

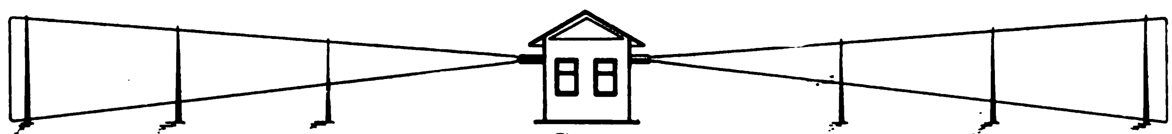


Figure 31

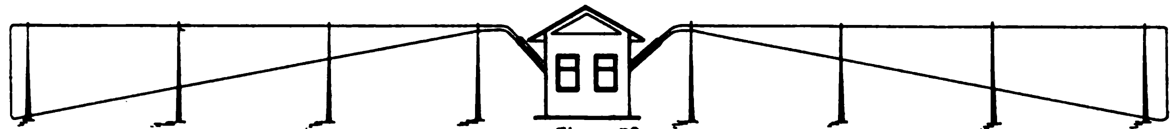


Figure 32

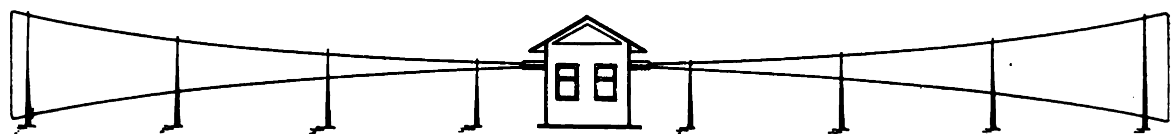


Figure 33

Figures 29 to 33—Experimental forms of the Weagant loop antennae designed to have graded constants

Immediately underneath the closed circuit loops is a long low horizontal antenna A-1, 6000 feet long (in the Lakewood installation) which, through the medium of the coils L-15 and L-16, is coupled to the intermediate tuning circuit, which circuit also includes the rotating coil of the goniometer. All three antennae lie in the same plane and are preferably pointed in the direction of the sending station.

In contrast to the two aerial system, of figure 18 and others following, the two loops in this arrangement are used to build up the static currents and to balance out the signal currents. The two loops then constitute a static tank in which static currents of any desired frequency may be stored up, so to speak, for balancing purposes.

The long low horizontal antenna A-1 on the other hand, picks up both static and signals and its primary coils L-15 and L-16 also act upon the detector circuits. By effecting proper coupling and connections between the static tank and the receiving aerials, the static currents accumulating in the static tank can be brought into opposite phase with the static currents in the horizontal antenna, resulting in substantially complete annulment, yet retaining the full strength of signal. In fact, Mr.

Weagant pointed out that the strength of the resulting signal was equal to that obtained with the two aerial arrangement when it was adjusted to give maximum signal currents rather than maximum static currents.

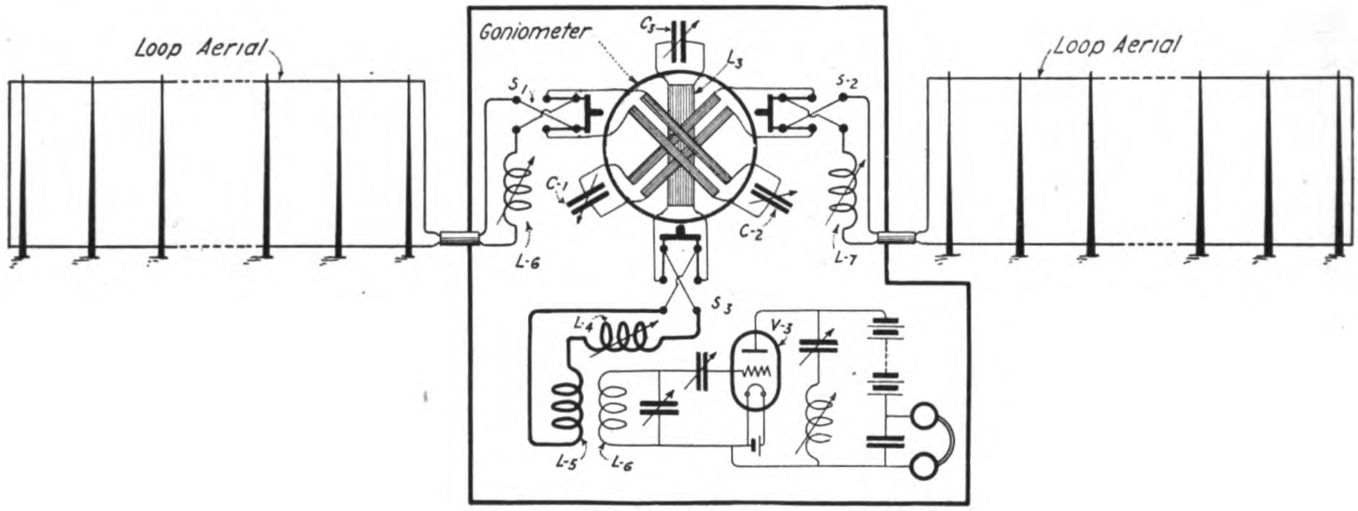


Figure 34—Circuits of the Weagant two-aerial system for static elimination showing the position of the goniometer and the necessary reversing switches for obtaining a satisfactory static balance. In this circuit the variable condensers are connected in series with the goniometer coils

How "Clicks" and "Grinders" Accumulate in the Static Tank

The fact that the static tank becomes a source of static currents of both the *click* and *grinders* type requires some explanation. For it would appear that since the "clicks," which have been classified as a type of static that is propagated horizontally, would be neutralized as are the signal currents when the goniometer is adjusted to annul signals. The static tank, however, has proved to be a source of both "clicks" and "grinders" as will now be explained.

Assume the reception of highly damped static waves from left to right or vice versa upon two loop aerials such as shown in figure 37, giving one-half wave length separation for the signal wave; the static wave acts first upon one aerial and then on the other, with the result that the first half-cycle of the highly damped oscillation in the first aerial is unopposed, because the current has had time to go through a complete half-cycle, before the wave continues its motion and affects the second loop.

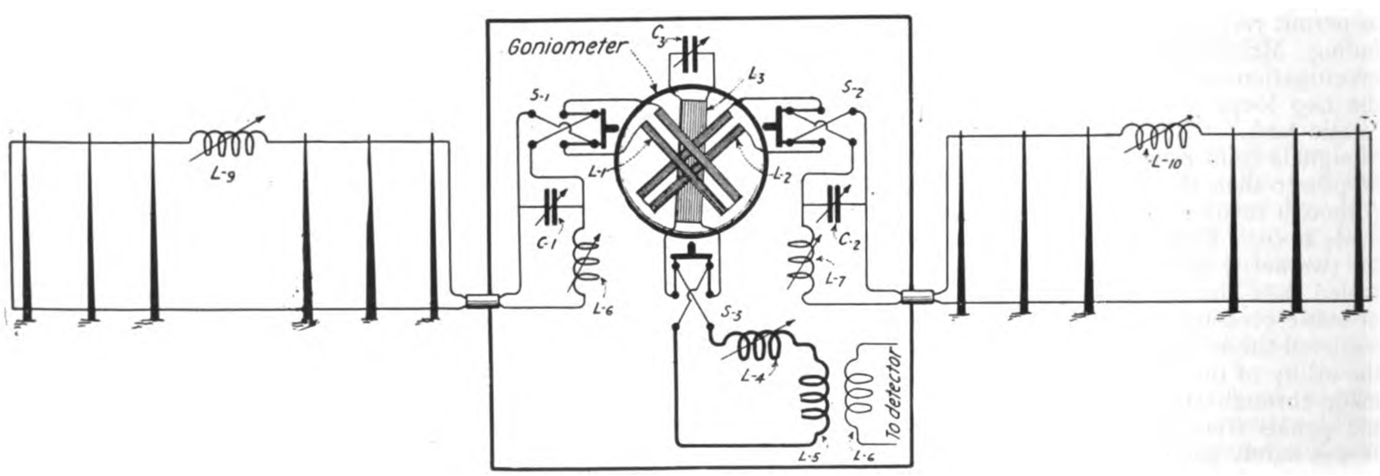


Figure 35—A modification of figure 34 employing parallel tuning. The condensers C-1 and C-2 are connected in parallel with the leads from the loops

The current generated in the second loop then flows back to the receiving apparatus. Further consideration will reveal that the first half-oscillation from the second aerial is opposed to the second half-oscillation from the first aerial, and so on throughout the wave train. But because the oscillations are damped, the opposing cycles in the first and second loops do not have the same amplitude and accordingly the result of the opposing oscillations is not zero as shown in figure 38. In other words, useful amounts of the click type of static as well as the grinders type are retained by the static tank and may be used to balancing out similar static currents in an ordinary receiving aerial. Still better results are secured by damping heavily the loop antennae through the insertion of series resistances until the wave trains, due to static, become shorter and shorter until all the energy is dissipated in the first half-cycle. Under these conditions, although the loops are coupled to the receiving set so that the wireless signal completely cancels out, the entire static current remains, resulting in the curious curve shown in figure 39 which comprises two half-oscillations, both in the same direction.

Mr. Weagant was careful to point out that the first half-oscillation of the signaling current is also unopposed, but in the case of undamped wave reception only 1/7000 part of the energy which is required to make a dot effects the detector; in other words, the static tank retains a very slight amount of the signaling current even when the loops give one-half wave lengh separation. A general order of the result obtained with the most effective spacing, may be secured with any appreciable wave length separation; that is, although the loops may have fixed dimensions, they can be worked over a considerable range of wave lengths with slight decreases in the intensity of the signals.

In regard to the reception of the clicks propagated at an angle to the planes of the loops, it is interesting to note that as the angle increases, the resulting static pulses

overlap, as shown in figure 39-A; and, as Mr. Weagant pointed out, through part of the azimuthal angle, the intensity of the oscillations produced by static vary along the cosine curve, spreading out somewhat as the angle increases. If, therefore, this system is balanced against a third aerial, the curve of reception of which is a cosine curve and both signal and static currents are flowing, the static currents due to the click type of static will oppose and the residue will be the order of the difference between the dotted curve shown in figure 40 and the cosine curve shown in the solid lines. From this it is apparent that a very large order of reduction is possible, retaining the full signal strength developed by the third aerial.

Early Form of the Static Tank

One of the early methods of using the static tank is shown in figure 41, wherein the cages or loops A and B are separated several thousand feet and connected to a centrally located receiving set by long low horizontal leads. The loop E, which in this case is the receiving antenna, is also coupled to the receiving set. Like the method shown in figure 37, loops A and B are employed as a static tank and loop E is the receiving aerial which picks up both static and signal waves. The procedure in this case is as usual in the three aerial system; the loops A, B and E, are all tuned to the frequency of the incoming signal, but A-1 and A-2 are coupled to the common receiving circuit in such a way that the signal balances out, the static currents being retained. The loop E picks up both static and signals and is also coupled to the receiving circuit. By proper adjustment of couplings, etc., a complete static balance is obtained.

The "Whippet" Static Tank

In order that the static tank aerials may give one-half wave length separation, very long antennae, up to six miles in length, are required for the longer waves employed in wireless communication from continent to continent. Offsetting any objection which might arise on this score, Mr. Weagant astonished his listeners by describing a miniature form of static tank and associated receiving aerial capable of transoceanic reception, which could be mounted upon the speaker's platform. He described the arrangement illustrated in figure 42, which, in addition to acting as a static tank, serves to prove that electromagnetic waves while in transit may be considerably distorted from their initial angle in respect to earth.

In brief, a horizontal antenna A-1, 25 feet in length is mounted on a "tether" arm B, which may be rotated around its vertical axis on the pivot P and placed at any angle in respect to the earth. The horizontal antenna mounted on the "tether" is associated electrically with the closed circuit loop A-2 which is employed as a receiving antenna. The "tether" antenna is employed as a static tank; that is, it may be made a source of static currents, but not a source of signal currents. The loop, on the other hand, is a source of both static and signal currents and the static currents therein may therefore be opposed to those in the "tether" and thus be annulled.

In point of explanation of the phenomenon of the pivoted antenna: It has been believed for some time that because the earth is not a perfect conductor, the wave front of horizontally propagated wireless waves may not be strictly vertical, but may be tipped forward or backward at an angle to the horizontal. Weagant was the first to prove this in practice, for he found that by tilting the antenna A-1 of figure 42 at various angles to the horizontal and pointing it in the proper direction, an angle can be found which presumably is normal to the wave front of the signals and at which the antenna will not pick up signals; but it continues to pick up static which was to be expected on the assumed theory of vertically propagated static waves. The "tether" antenna then becomes a static tank, but the correct angle, of course, must be found for each transmitting station in order that the tank will not pick up the signaling wave.

Mr. Weagant has found that the "tether" antenna determines the angle of the advancing wave with remarkable accuracy, it being possible to determine the position for minimum signals within one or two degrees.

To illustrate more clearly the assumed operation of the "tether" antenna, a possible direction of wireless telegraph waves is shown by the single pointed arrows in figure 42; the vertical propagated static waves by a number of double pointed arrows. When the "tether" antenna A is adjusted at a right angle to the actual wave front, no electromotive forces will be induced therein. The static waves, however, act upon the "tether" antenna and induce therein electromotive forces, the frequency of which can be adjusted to the same value as the frequency of the static currents induced in the receiving loop A-2. Since the loop antenna A-2 is a source of both signal and static currents, the static currents of the "tether" antenna A-1 may be opposed to the static currents in the loop A-2, retaining the signal.

The two antenna in figure 42 may be, of course, coupled through the agency of a goniometer to obtain the desired static balance. The diagram simply shows the fundamental connections of the circuit.

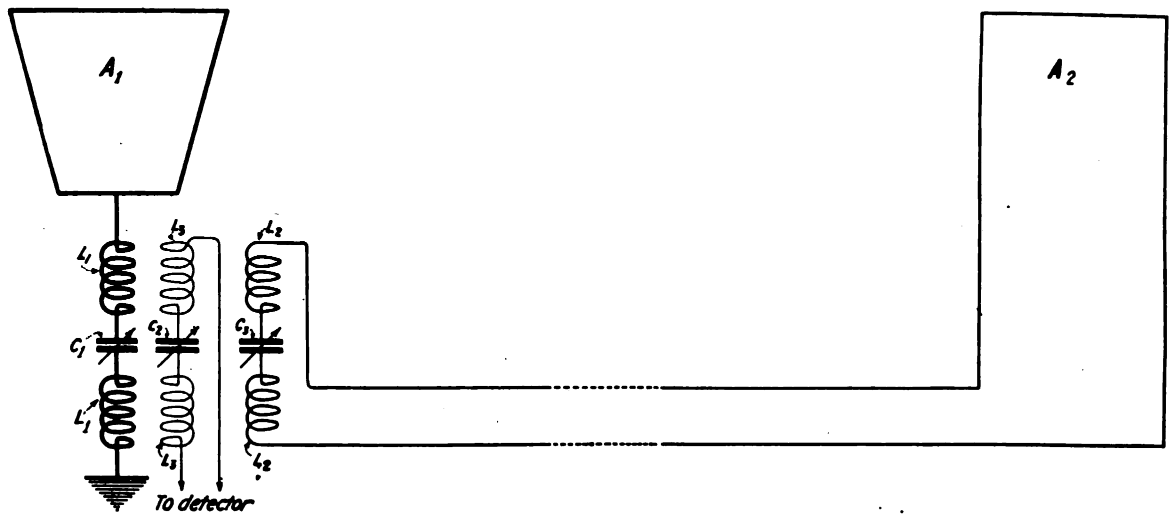


Figure 36-A—Showing the antenna structures employed by Weagant in the early experiments at Belmar. A loop connected up as a straight-away aerial was grounded to earth and balanced against a loop, with long low horizontal leads

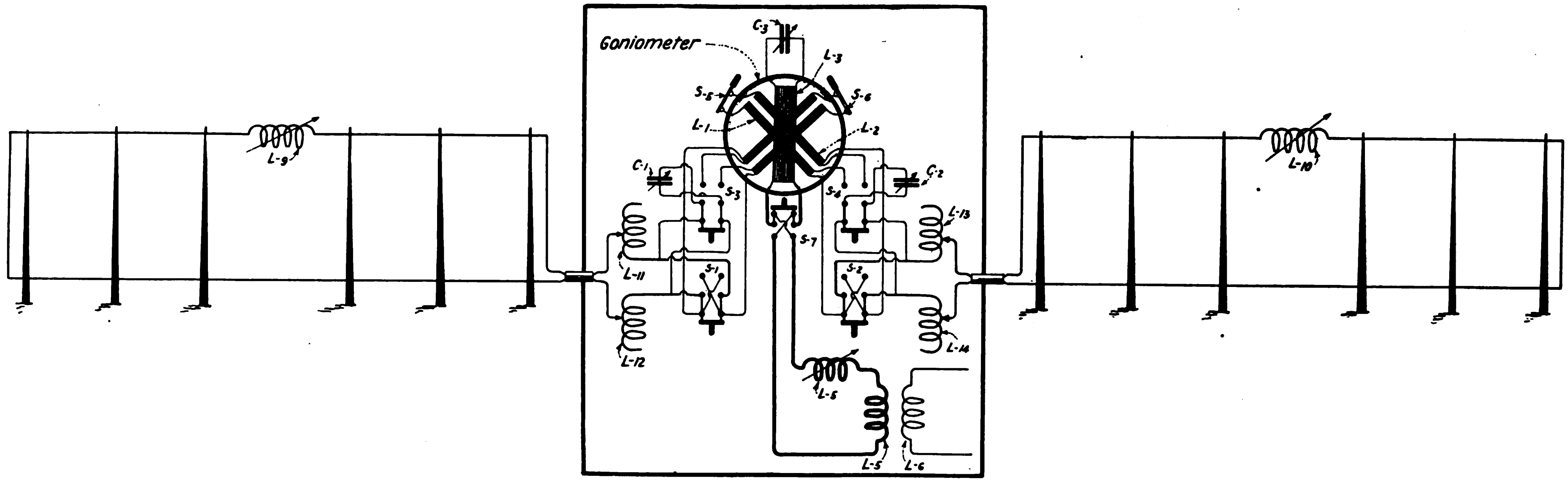


Figure 36—Complete circuits of the Weagant two-aerial system providing either series or parallel tuning. Switches S-1 and S-2 reverse the connection between the goniometer coils and the loops. Switches S-3 and S-4 place the variable condensers C-1 and C-2 either in series or in shunt with the stationary goniometer coils

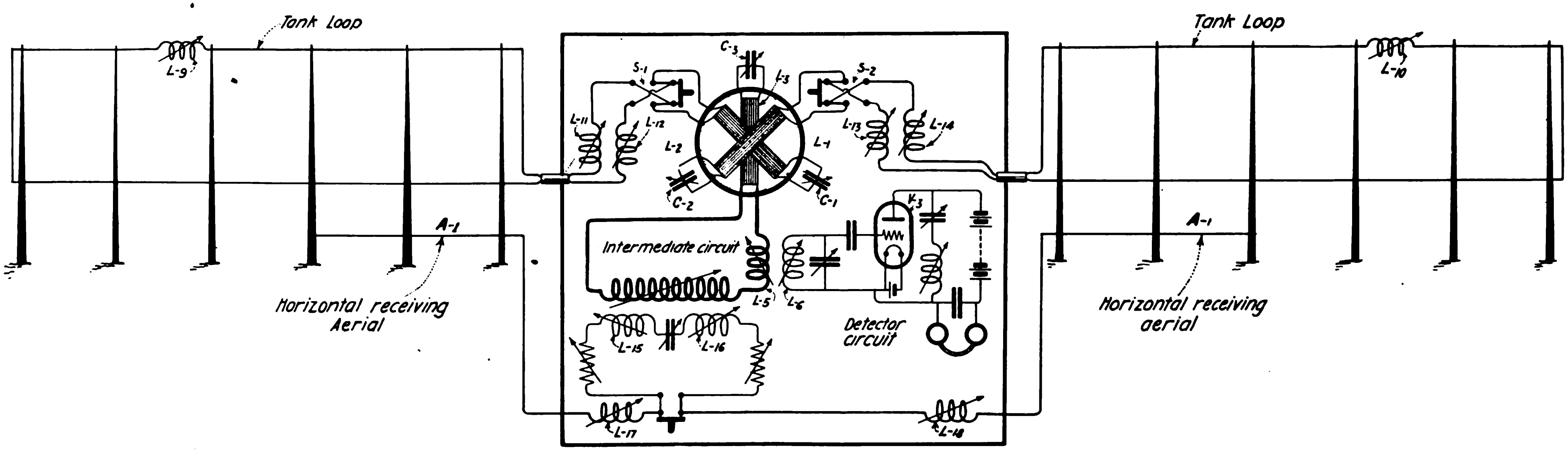


Figure 37—Fundamental circuits of the Weagant three-aerial system wherein two loops are used as a "static tank." This is the preferred method of annulling the interference of static waves. In accordance with the principle of this discovery two single turn loops are used in such a way that they become a source of static currents of any desired frequency but not a source of signal currents. The main receiving aerial is a long low horizontal wire A-1. This and the static tank are coupled to the receiving circuits within the station. The static tank is a source of static currents of both the clicks and grinders type. By proper adjustment of inductances, capacities and resistances in the static tank and the receiving aerial, and by finding a suitable position for the goniometer coil L-3, static currents of the frequency of those induced in the receiving antenna can be drawn from the static tank to balance out the static currents in the horizontal receiving aerial thus retaining the full strength of the signal current. So successful is this system in removing the most troublesome types of static interference that it permits 24 hour transoceanic wireless reception without interruption

It is to be noted that a condenser in dotted lines is connected across the tuning elements of the "tether" antenna. This is the preferred connection for average working.

Owing to the very small length of the "tether" antenna A-1, large loading inductances must be inserted in the central point to obtain resonance with a transmitter operating at long wave lengths; and an eight-stage amplifier is required to bring the signals up to practical audibility. It is interesting to note that with an amplifier of such capabilities, when properly designed, a very small loop A-2 will give readable signals from high power stations several thousand miles distant.

A variation from the arrangement in figure 42 is shown in figure 43; here two pivotal antennae A-1 and A-2 are constructed as the "tether" antenna of figure 42 so that they can be placed at any angle in respect to the direction of the advancing wave. The antenna A-1 is then adjusted, let us say, to a certain angle with the horizontal so that it will be unresponsive to the desired signal. Next, the antenna A-2 is set at an angle to the horizontal so that it will be responsive to both static and signals. The antenna A-1 as before, constitutes, a static tank, whereas A-2 is a source of both static and signaling currents. Either of the antennae, of course, can be used as a static tank and the other as the receiving antenna.

By the use of multi-stage valve amplifiers to bring the incoming signals to audibility, such small antennae are perfectly feasible for the reception of radio telegraphic signals over great distances and it is quite possible that they will be employed in commercial practice.

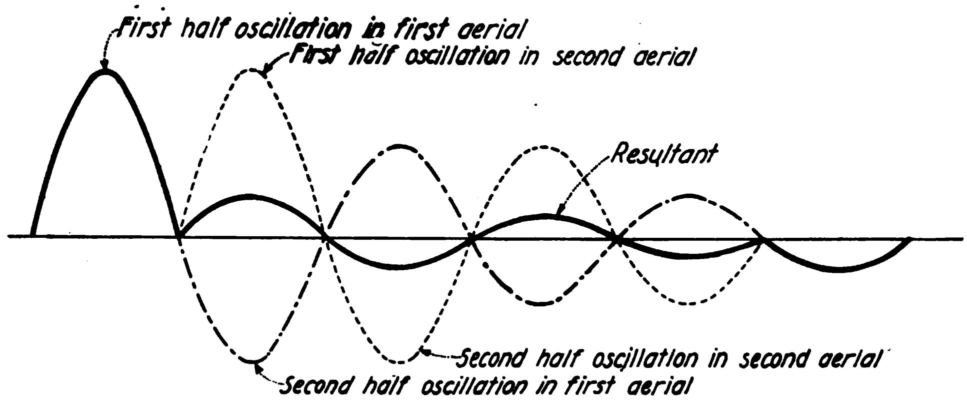


Figure 38—Graphs showing how the Weagant static tank retains "clicks," a type of static which is assumed to be propagated horizontally as electromagnetic waves. It would appear that since the static tank balances out horizontally propagated signaling waves, it would affect likewise, horizontally propagated static waves; and as a consequence, the static tank would become only a source of "grinders" providing no means for balancing out the "clicks" in the horizontal receiving aerial. The fact remains, however, that the static tank picks up and retains the energy of both grinders and clicks as will be evident from the curve. It will be seen that because the horizontally moving static wave acts first upon one aerial and then on the other, the first half oscillation induced in the first antenna is unopposed. The second half oscillation in the first aerial, however, is opposed by the first half oscillation of the second aerial and so on throughout the wave train. The resultant of these two graphs obviously is not zero, and hence sufficient amounts of the static currents of both the clicks and grinders type are retained for balancing purposes

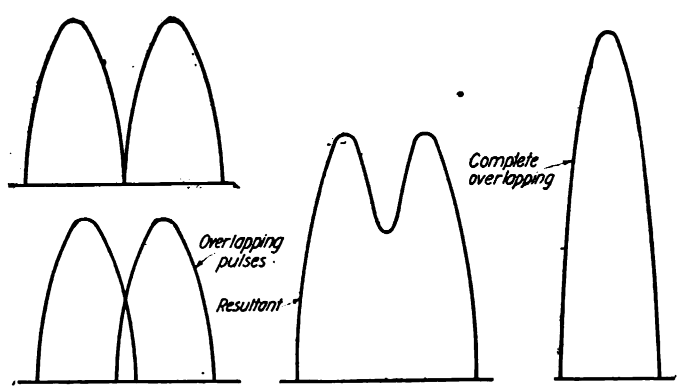


Figure 39—Upper left hand diagram. Showing the wave form of the resulting static currents in the Weagant static tank generated by "clicks" when the loop aerials are heavily damped by the insertion of resistances

Figure 39-A—Curves showing the wave form of static currents generated in the static tank by horizontally propagated "clicks," as the angle of the clicks increase in respect to the plane of the static tank

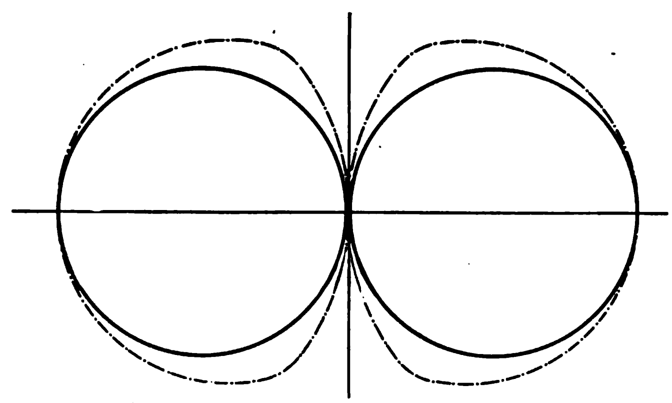


Figure 40—Reception curves of the Weagant static tank and the receiving aerial. The difference between the areas of the two curves shows the residue of static, which is practically negligible

COMMERCIAL ASPECTS

Only those who have been actively identified with the radio art through its progressive steps and have had the opportunity to observe for themselves the magnitude of the interference engendered by static waves, can realize the boon which the Weagant system has given to commercial long distance wireless telegraphy. With ordinary apparatus and aerials, continuous transoceanic working, particularly during the summer months, was impossible; but such reception is now possible not only with lesser amounts of power at the transmitter, but with a much less expensive antenna structure at the receiving station, giving a better static balance than that obtained with the former costly types of aerials with high towers.

No better estimate of the commercial practicability of the Weagant system can be given than that presented by the inventor himself. He said:

"Continued use has established beyond question that this performance is not occasional, or accidental; it is consistent. With this arrangement transatlantic radio telegraphy can now be carried on free from interruptions due to static of any kind whatsoever except local lightning. This cannot always be neutralized, but since the cables are also interrupted by this latter cause, it follows that a continuity of communication equal to that of cable

operation is now possible by radio telegraphy, while the latter has the great advantage of cheapness and greater speed of operation. For many years attempts to work automatic high speed radio telegraphy have been made,

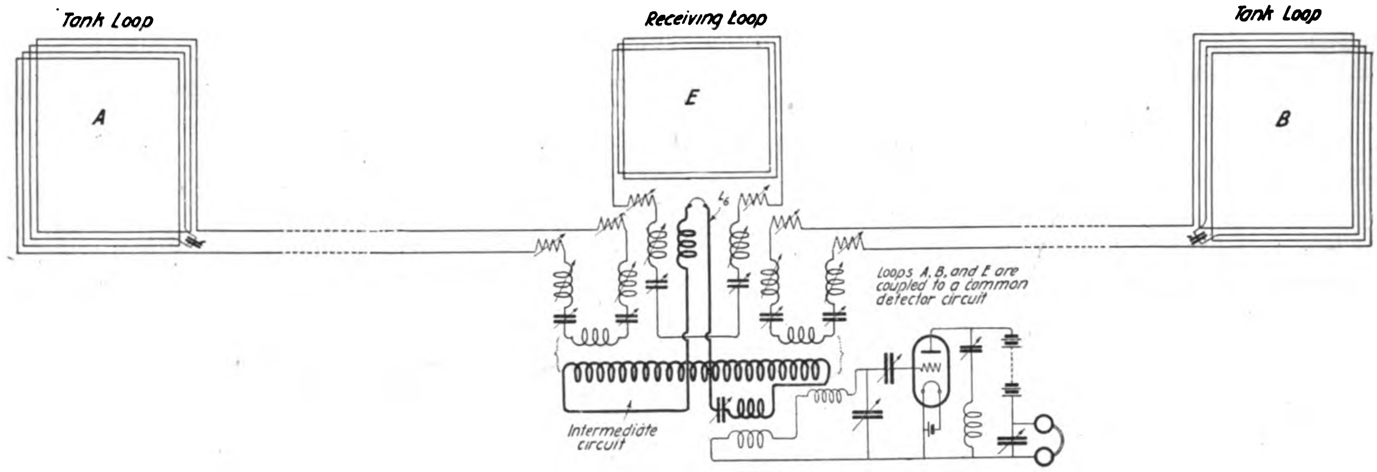


Figure 41—An early form of the Weagant static tank employing three cages or loop aerials. Loops A and B, separated several thousand feet are employed as a static tank and are coupled to the detecting apparatus in such a way as to build up the static currents and eliminate the signal current. Loop E is the receiving aerial which picks up both static and signals. The static currents flowing in the tank loops are balanced against the static currents in the receiving loop resulting in annulment, while retaining the signal

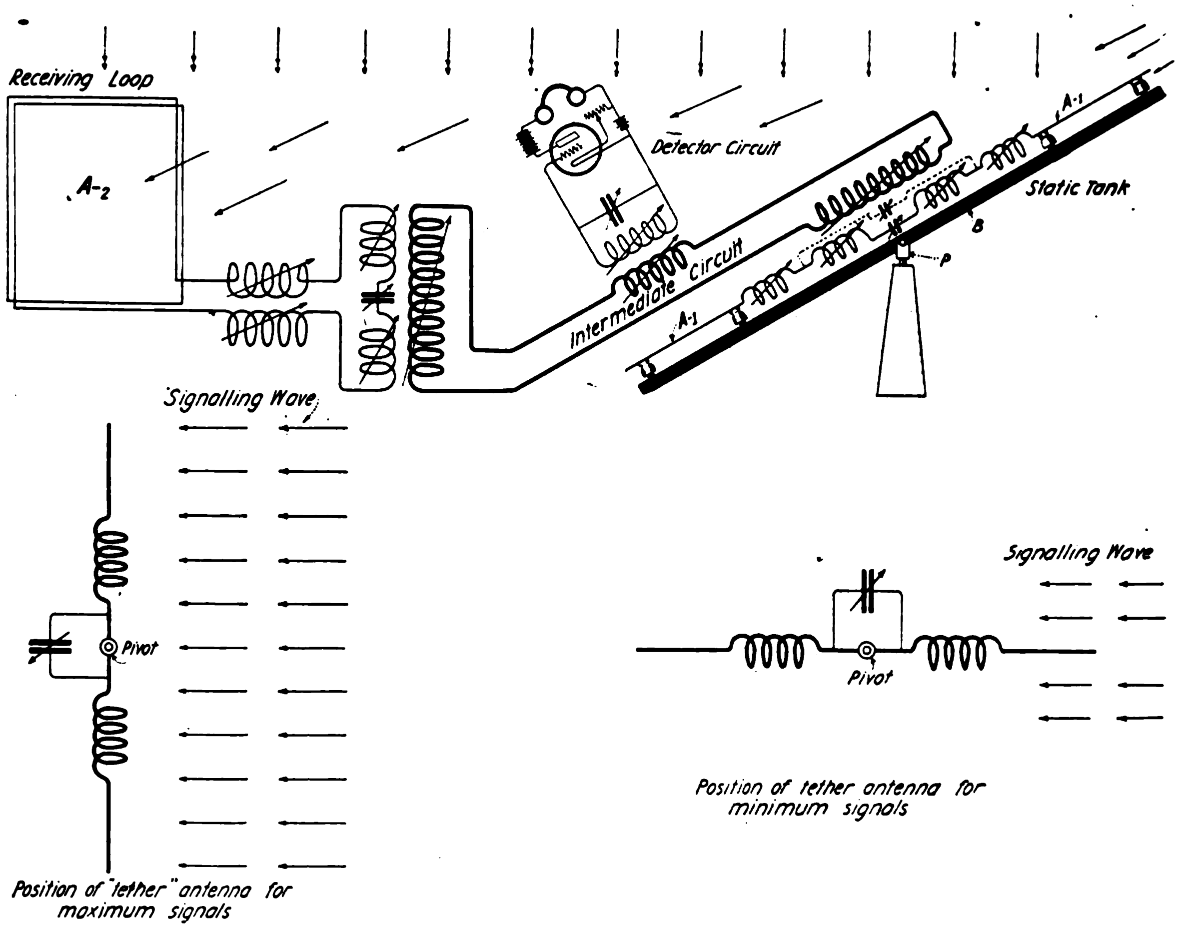


Figure 42—The Weagant "whippet" static tank—a discovery which presents some interesting novelties. In this system a horizontal aerial A-1, not over 25 or 30 feet in length is mounted on an arm B which may be revolved on a pivot P and placed at any angle in respect to the horizontal. The receiving loop A-2 is a closed coil of a few turns of wire, four or five feet square. Both aerials are coupled to a common detector circuit. By pointing the horizontal or "tether" antenna in the direction of the transmitting station and placing it at the correct angle in respect to the earth, a position can be found which is normal to the wave front, and at which the horizontal antenna will not respond to a given signal wave, but to static waves only. It thus becomes a static tank. The receiving loop collects both static and signals, and the static currents therein are balanced against those generated in the horizontal aerial.
Through the use of an ingeniously designed eight-stage amplifier the signals emanating from high power stations several thousand miles distant can be brought up to practical audibility with these antennae. In the diagram, the assumed direction of a distorted signaling wave is indicated by the single pointed arrows and the vertically propagated static waves by the double pointed arrows. It is readily seen that no electromotive forces will be induced in the horizontal antenna by the signaling wave, but it is acted upon by vertically propagated static waves. The two lower drawings show the position of the horizontal antenna for maximum and minimum signals

but they have been successful only when static was absent. It is therefore evident that use can now be made of this method of working to a very great extent, thereby greatly increasing the number of messages which can

be handled over a given circuit. It may also be stated that the great barrier in the way of successful, practical radio telephony has been removed since static has interfered with radio telephony to a much greater extent even than with radio telegraphy." This summarizes the practical values of the Weagant anti-static invention.

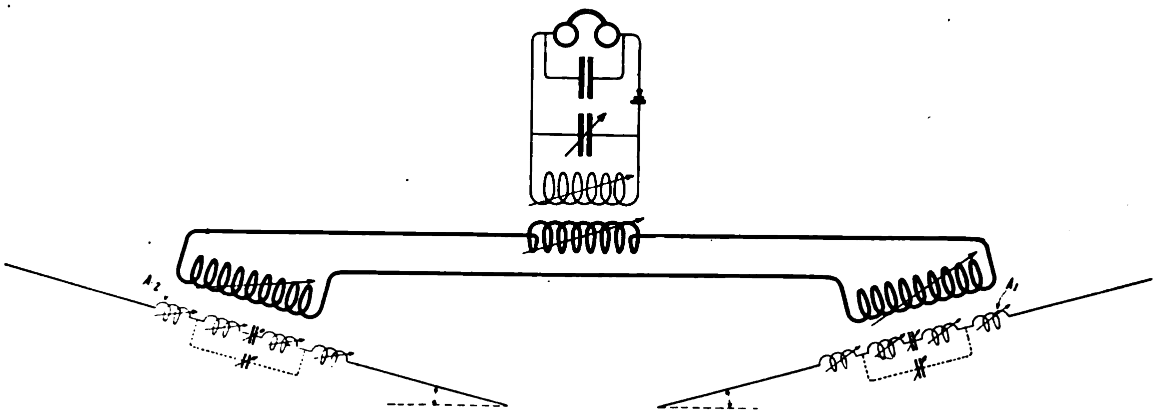


Figure 43—A modification of figure 42 where two short horizontal aerials are mounted on a "tether" arm, one being used as a static tank and the other as a receiving antenna. One antenna is set at such an angle in respect to the horizontal as to be responsive to both signals and static while the other is placed so that it is responsive to static only. Both antennae are coupled to a common receiving circuit wherein the static currents are opposed, the signal current being retained as in the several foregoing methods

Fuller's Method of Signaling with Arc Transmitters

DURING a sending period, the arc gap of arc transmitters must operate continuously. Signaling is accomplished by detuning the antenna circuit to a different wave length than that to which the receiver is adjusted. The usual method is to vary the antenna inductance by short circuiting a portion of the turns during the signaling periods. The antenna radiates a wave of one length when the key is depressed and a wave of another length when the transmitting key is open. A difference of 100 meters is generally sufficient for signaling. In high power transmitting stations large currents must be handled by the short-circuiting apparatus, and some difficulty has been experienced in opening and closing the circuits.

The well known method designed by Fuller provides an electromagnetically operated relay key which performs the function of short-circuiting a fraction of a turn of the aerial tuning inductances at several points.

Several turns must be short circuited by the multiple contact key in order to produce the desired change in wave length. By breaking the inductance into a plurality of sections, and short circuiting each section independently, only a portion of the energy impressed on the key circuit is handled by each contact. The energy handled by each contact is substantially constant, irrespective of whether the various circuits are opened simultaneously or at different times in any sequence. The preferred method of operation is, of course, to have these contacts open and close together.

In the diagram, taps are brought from the aerial tuning inductance 2 to various parts of the signaling key. The armature of the signaling key makes contact with the studs 15, 16, 17 and 18 short circuiting the turns and thereby changing the antenna wave length.

Fuller has disclosed other means of controlling the antenna current in an arc system as indicated in figure 2, in which a shunt oscillation circuit 12, 9 and 8 is connected across the arc gap proper 2. The spacing of the electrodes at 12 is preferably such that normally a very small amount of current will pass across the arc making the shunt circuit practically an open circuit and confining the oscillations generated by the arc 12 to the antenna circuit.

The resistance of the arc gap is preferably such that the current will spit across the arc gap spasmodically but will not flow continuously. Means are then provided for impressing an additional voltage on the arc 12, to reduce the resistance and form a shunt path for the current from the arc 12. The additional E.M.F. is provided by the DC generator 13, the circuit from which is closed by the key 14, the arc in which is extinguished by a magnetic blowout or other means.

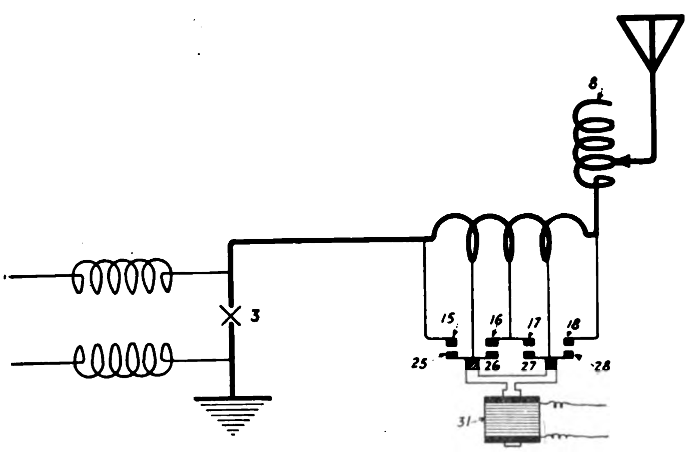


Figure 1—Diagram showing taps from the aerial tuning inductance to parts of the key

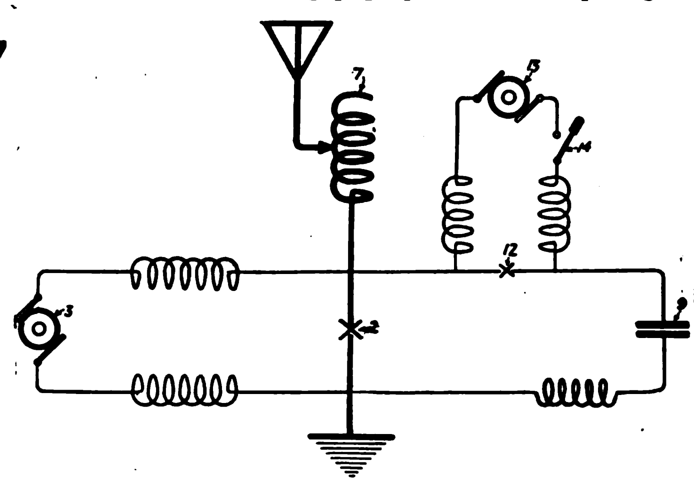
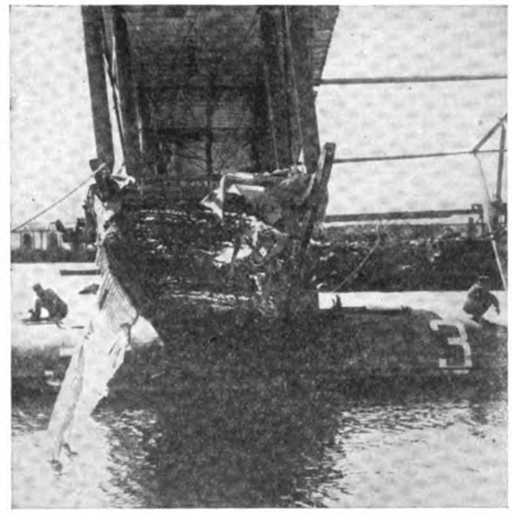


Figure 2—Diagram showing the use of a shunt oscillation circuit

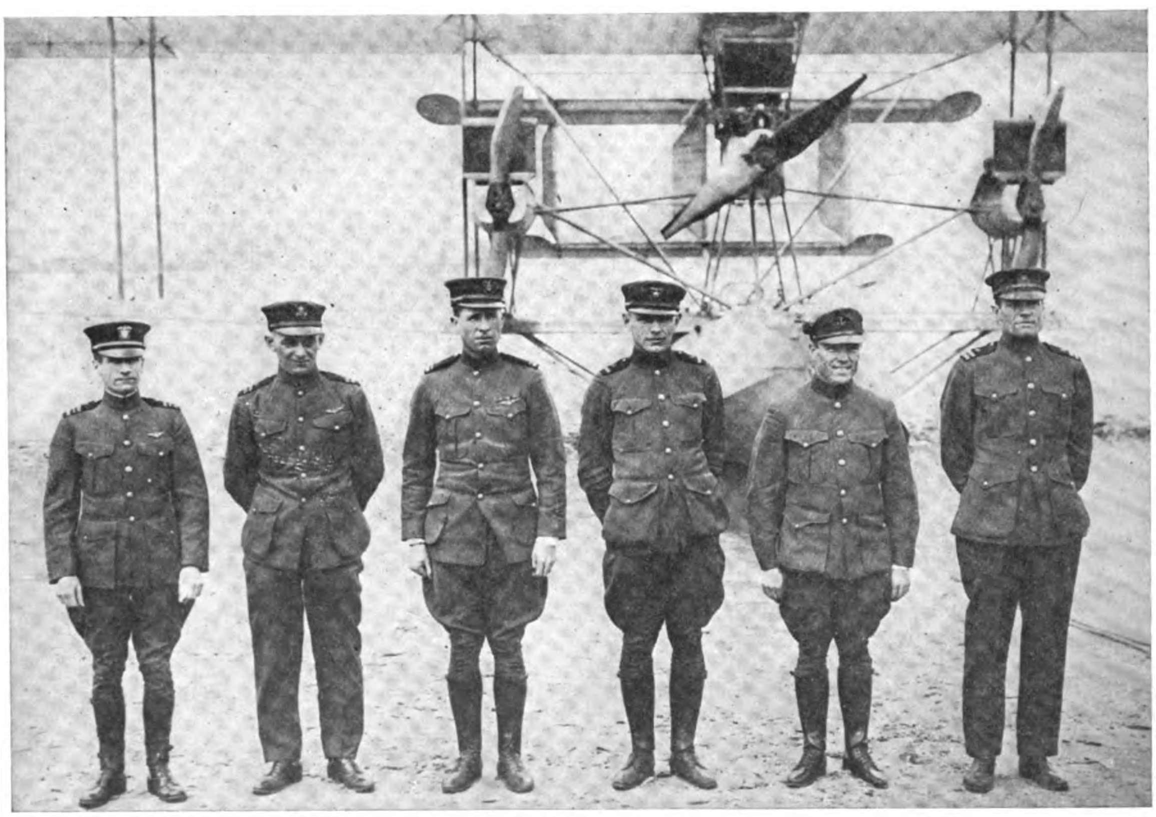
AIR MEN



Above: The NC-3 arriving at Ponta Delgada with lower wing damaged by the waves

To the left: Harry Hawker, the English aviator, who contested with American naval men the first honors of trans-Atlantic flight, but who was forced down in mid-ocean by engine failure

Press Ill. Svce.



The victorious crew of the NC-4, the first airplane to fly across the Atlantic; Ensign H. C. Rodd, wireless operator is fourth from the left. The others are, left to right, Lieut. Commander A. C. Read, commander; Lieut. E. F. Stone, pilot; Lieut. (j g) Walter Hinton, pilot; (Ensign Rodd) Chief Special Mechanic E. H. Howard, engineer (injured by propellor blade at last moment and could not go), Lieut. J. L. Breese, reserve pilot engineer

Cascade Amplification by a Single Vacuum Tube

A VACUUM tube for cascade amplification of variable E.M.F.'s without intervening transformers has been developed by Alexander Nicolson. The structure of the tube is shown in figure 1 and a circuit diagram in figure 2. The underlying principle of operation is as follows:

The input E.M.F. is impressed between the first section of the cathode and its associated input element, and serves to vary the discharge from the cathode section to another electrode which is maintained positive with respect to the cathode section. By inductively isolating it from the output circuit of the system, the electrode in question is made to function as an input element with reference to the second section of the cathode, and, by virtue of the varying charge delivered to it from the first cathode section, is made to vary the discharge from the second cathode section to a second electrode maintained positive with respect to that section. It, in fact, serves the double function of an anode for the cathode section and an input element for a third section.

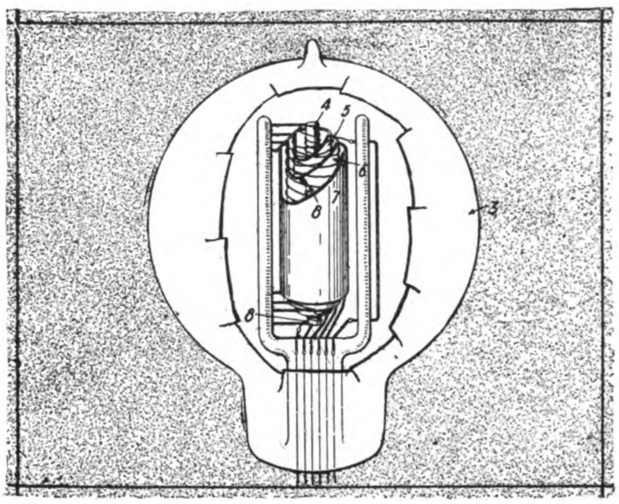


Figure 1—Showing the construction of the vacuum tube used in cascade amplification

Referring to figure 1, 3 is an evacuated vessel containing a group of concentrically arranged cylindrical electrodes 4, 5, 6 and 7. A filamentary cathode 8 is wound first about the outer surface of electrode 4, passing from electrode 4 to electrode 5 and from electrode 5 to electrode 6 and from electrode 6 to the leading-in wire.

The electrodes 4, 5, 6 and 7 are preferably made of nickel, and in the case of 4, 5 and 6 the outer surface is oxidized so as to form a dielectric or insulating film between the cathode filament 8 and the electrode on which the filament is wound.

The operation of the device as an amplifier will be more clearly understood by reference to figure 2. In this figure 8a is that section of the filament which is wound around electrode 4; and 8b and 8c are those sections which are wound on electrodes 5 and 6, respectively. The filament 8, as a whole, is heated to incandescence by a battery 15 and the input is impressed between this filament and the main input electrode 4 by means of the transformer secondary 17, the primary 16 of which is connected to the source of telephonic or other currents of varying frequency to be amplified.

The electrode 5 which is maintained positive with respect to the cathode section 8a by battery 18 serves as an anode with respect to this cathode section and with respect to the input electrode 4, and receives a varying charge by virtue of the variation in thermionic current flowing from the cathode section produced by the input E.M.F. The electrode 5, instead of being directly connected to the output circuit, as in former audion arrangements, is here inductively isolated therefrom by the impedance coil 19. The varying charge thus received by electrode 5 causes it to act as an input electrode for the cathode section 8b by varying the thermionic current from that cathode section to its inclosing cylindrical electrode 6. The latter in turn is inductively isolated from the output circuit by impedance coil 20 and serves as an input electrode for the cathode section 8c. The anode 7, associated with this cathode section 8c is included in the output circuit which comprises transformer primary 21, batteries 22, 23 and 18, and cathode 8.

It is important that in the arrangement shown the filament section 8a be connected to the negative terminal of battery 15 and that section 8c be connected to the positive terminal of the battery. Thus, because of the potential drop in the filament 8 as a whole due to the flow of heating current through it, the section 8a will be more negative with respect to electrode 5 than will section 8b, and similarly, section 8b will be more negative with respect to electrode 6 than will section 8c.

In the particular arrangement depicted the input energy is subjected to three distinct stages of amplification by what is the equivalent of three distinct audion arrangements. The first of these arrangements comprises electrode 4 as an input electrode, filament section 8a as cathode and electrode 5 as anode. The second, comprises electrode 5 as input electrode, filament section 8b as cathode and electrode 6 as anode, while the third comprises electrode 6 as input electrode, filament section 8c as cathode and electrode 7 as the final anode and output electrode. The battery 23 makes anode 6 more positive than anode 5, while anode 7 is more positive than anode 6 by reason of battery 22. Each anode is thus more positive than the one preceding.

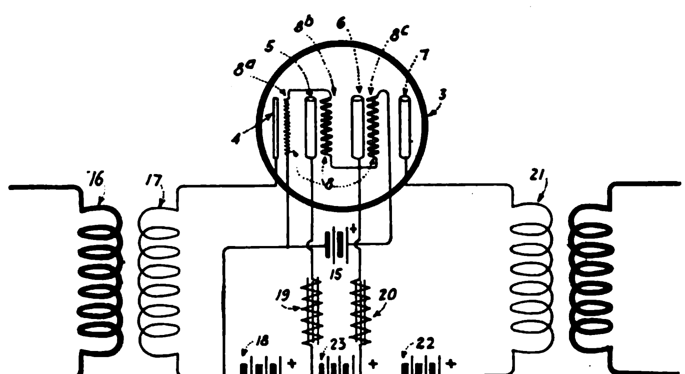


Figure 2—Diagram of circuit used in cascade amplification by a single vacuum tube

Hammond's Method of Modulating Antenna Current

It is generally understood in the art of radiotelegraphy that if a properly designed undamped wave transmitter and receiver are operating in resonance, a change in wave length of 1/10 of 1% at either the transmitting or receiving station will destroy the condition of resonance between them. Any device which will provide the necessary change of wave length at audibility rates may be employed for telegraphic signaling.

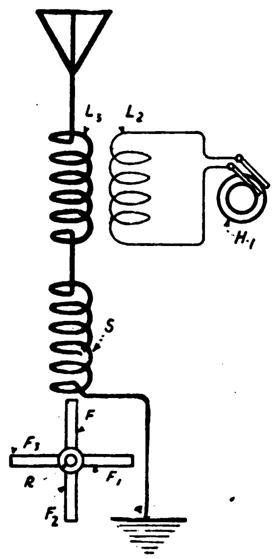


Figure 1—Illustrating the method used to vary the antenna circuit inductance

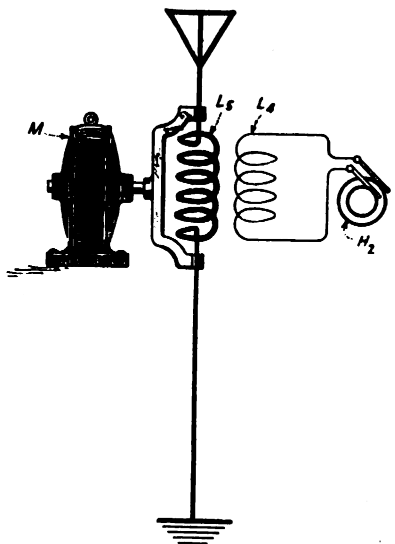


Figure 2—Showing method of controlling the output of the alternator

The necessary change in wave length may be produced by changing either the capacity or inductance of the oscillatory circuit. In fact, if a change of 1% be made in either the capacity or inductance of the transmitter, a change of perhaps 100% may be caused in the intensity of the received signals at the receiving station.

By periodically varying the capacity or inductance at a transmitting station such as shown in the accompanying figures 1 and 2, it is possible to produce at the receiving station an impulse of a sinusoidal character.

Hammond claims to have discovered that the variation produced in the transmitting apparatus to give signals at audio-frequencies is preferably of a very peaked form rather than of a sinusoidal form, the reason being, that due to the resistance of the receiving circuits, there is a tendency to flatten out the wave form. Therefore, to produce sinusoidal waves at the receiving station a very peaked wave form is necessary at the transmitting station.

In figure 1 a method of varying the inductance of the antenna circuit is shown. The high frequency alternator H-1 impresses undamped oscillation upon the antenna circuit through the coupling L-2, L-3. Another inductance S is included in the antenna circuit which is in magnetic relation to a rotating element R having pole pieces F, F-1, F-2 and F-3. As R is rotated, periodic variations of the inductance of S occur causing the antenna circuit to be thrown out of resonance with the high frequency alternator. The periodicity of the amplitude variations thus produced depends upon the speed of the rotating element R and upon the number of its pole pieces.

In the diagram of figure 2 the coil L-5 is mechanically attached to the motor M and rotated in respect to L-4 so as to vary its inductive relation. In this way, the amplitude of the antenna current is varied periodically at any desired frequency and the output of the alternator H-2 in accordance.

Methods of Varying Antenna Currents in Radio Telephony at Speech Frequencies

It has been found, in attempts to develop the art of radio telephony, that a serious limitation has been imposed by reason of the fact that any telephone transmitter at present known to the art is incapable of handling all the energy which is required for successful modulation of high frequency power for commercial radiotelephony.

H. J. Van der Bijl has devised several ways by which antenna currents are varied indirectly by a microphone and associated circuits employing the magnifying properties of vacuum tubes. The method depends upon the fact that an electromotive force impressed upon the input circuit of a thermionic amplifier of the "audion" type produces an apparent change in the impedance of its output circuit; in particular, a change in electromotive force impressed upon the input circuit, resulting from a change in impedance in a local circuit associated with the input circuit, causes the impedance of the output circuit of the amplifier to vary in such a way as to produce therein much greater changes in power than take place in the above mentioned local circuit. The thermionic amplifier in this case acts as a magnifying device for changes of power in the local circuit, and on account of this property a primary source of modulated power, capable of handling only a small amount of power, may be used to produce much larger changes in the transmitting antenna.

A variable impedance path, for example, the output circuit of a thermionic repeater is inserted into the transmitting antenna carrying high frequency currents, and thereby producing large changes in radiated power at the expense of but small changes of power in the telephone transmitter.

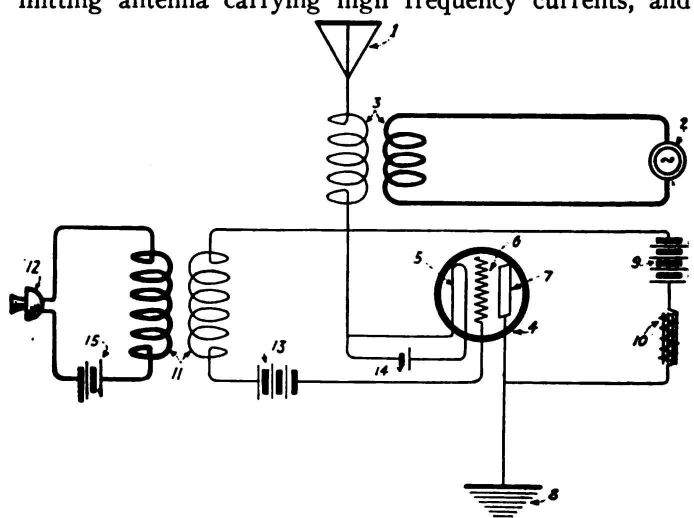


Figure 1—Diagram of a circuit used to connect an amplifier in series with an antenna

Figure 1 shows a method of connection of an amplifier in series with an antenna; figure 2 represents a preferred form which is better adapted to the modulation of large amounts of power, such as would be required in commercial operation; and figure 3 shows another method of placing the amplifier effectively in series with the antenna by means of a transformer.

Referring to figure 1, 1-8 is an antenna, 2 an alternator or other source of high frequency currents; 3 is a transformer between the antenna and the generator 2; 4 is a thermionic amplifier of the "audion" type having an electron-emitting cathode 5, a grid 6 and a plate 7. The antenna system is earthed at the point 8. The plate circuit is completed through the choke coil 10 and the battery 9. A transformer 11 serves to impress upon the input circuit of the amplifier variations in electromotive force caused by the microphone 12 in the local circuit. Batteries 13 and 14 are connected as usual in the operation of the amplifier, and battery 15 supplies current to microphone 12.

An objection to the circuit shown in figure 1 is that the output impedance of the thermionic amplifier, as at present constructed, is so high that it cannot be efficiently inserted directly into an antenna circuit. To overcome this difficulty, and to provide also for the modulation of larger amounts of power, a number of these elements may be connected in parallel as shown in figure 2, in which corresponding parts are denoted by the same numerals as in figure 1.

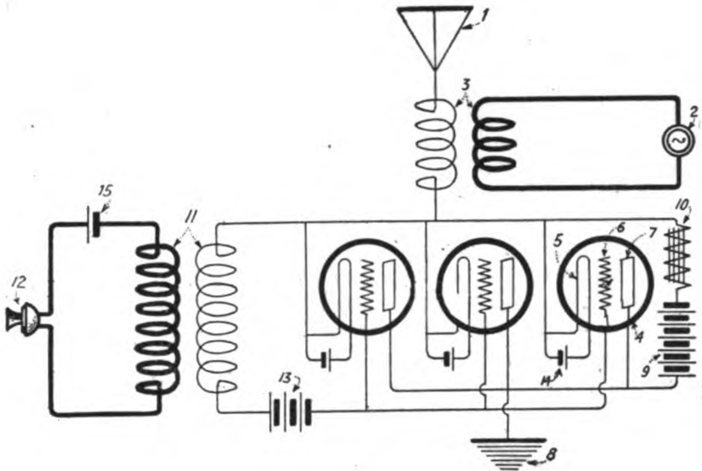


Figure 2—Another form suitable for the modulation of large amounts of power

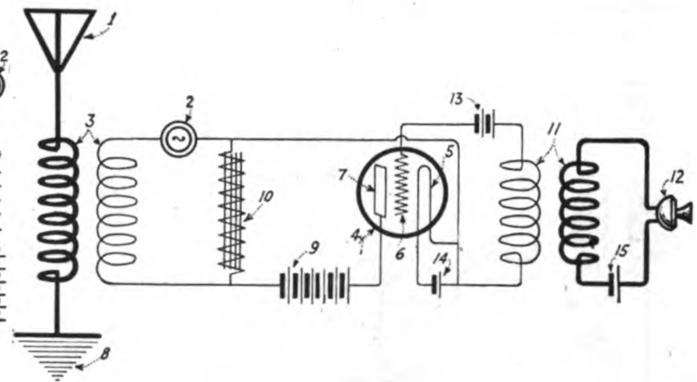


Figure 3—Method of placing the amplifier effectively in series with the antenna by means of a transformer

In figure 3, the variable impedance of the output circuit is placed directly in the generator circuit, but since that circuit is coupled to the antenna by transformer 3, this output circuit is effectively in series with the antenna and generator, since an impedance that is connected into a circuit by means of a transformer is equivalent, for forced oscillations, to a certain other impedance connected directly into that circuit. The function of the choke coil 10 is to exclude direct current from the generator 2.

The operation of the system is as follows: The generator 2 impresses high frequency power upon the antenna. Due to the choke coil 10, practically the whole of the high frequency current must flow through the amplifier and is superposed upon the space current of the amplifier. The choke coil is necessary in order to provide a conducting path for direct current in the output circuit. A variation in resistance in the microphone 12, due to voice waves impinging upon it, causes an electromotive force to be impressed upon the input circuit, which, in consequence of a well known property of the amplifier, produces an apparent change in the output resistance of the device, this change in output resistance causing a change in the amplitude of the high frequency antenna current.

Radio Call Apparatus

When continuous waves are employed for wireless transmission, it is often desirable to use very accurately tuned and highly selected receiving apparatus. This increases the liability of missing communications because a slight difference in the tuning of the receiver and transmitter, with continuous waves, completely eliminates the signals. In order to call the attention of a receiving operator whose apparatus is adjusted to a different wave length than that at which the transmitting station desires to work, John St. Vincent Pletts has devised the calling apparatus shown in figure 1.

It consists of a variable condenser H, a variable inductance F mounted on the shaft B coupled to a mechanical oscillatory system comprising a fly-wheel C and a spring D. If this device is connected in a wireless transmitter circuit and caused to oscillate mechanically, as by rotating the wheel, waves may be sent out which at first vary over a considerable range of frequencies and then over a smaller and smaller range until the wave length becomes constant. Such waves produce a distinctive sound every time they come into tune with a receiver and attract the attention of the operator, even though his receiver is not accurately tuned to the normal wave length of the transmitter.

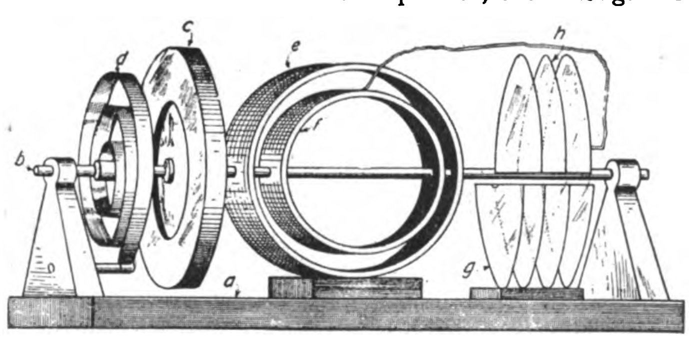


Figure 1—Showing the design of the radio calling apparatus

Undamped Wave Reception at Very Short Wave Lengths

IN receivers based on the interference or beat principle it is usual to employ a local oscillator which can be so adjusted as to produce oscillations differing in frequency by a desired amount from the oscillations produced in the receiver by the incoming waves. In some vacuum tube circuits the receiving device is its own local oscillator. The result is that during reception there are in the receiving circuits two sets of oscillations which interact with each other, producing a compound oscillation of varying amplitude. The receiver usually rectifies this compound oscillation into a uni-directional current of varying strength and so produces in the receiving telephone a note which has a frequency equal to the difference of the frequencies of the received and local oscillations.

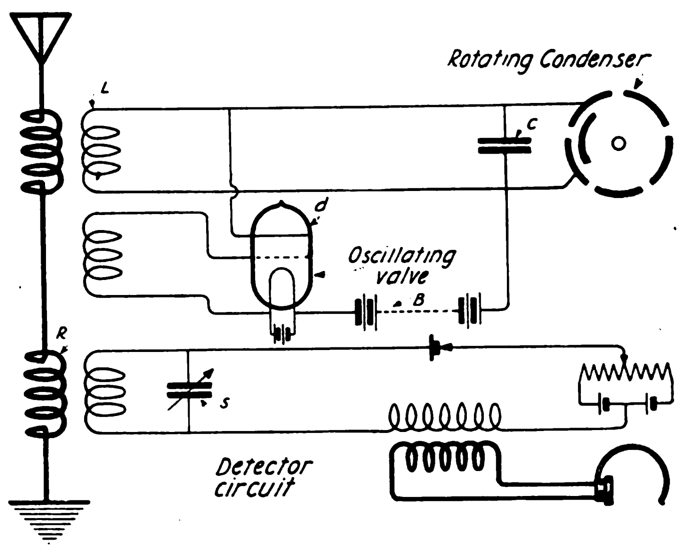


Figure 1—Circuit used in the new method of regularly varying the frequency of the local oscillations to permit undamped wave reception at short wave lengths

The constancy of the note depends upon the constancy of the frequency of the received and local oscillations. For frequencies below about 1,000,000 per second (300 meter waves) it is not difficult to maintain a sufficiently constant frequency; for frequencies about 3,000,000 it is still practicable though not easy to maintain a sufficiently constant frequency; for frequencies about 30,000,000 it is practically impossible to maintain the frequency sufficiently constant.

Assuming 30,000,000 to be the frequency received, then the local oscillator must generate a frequency of 30,001,000 or 29,999,000, in order to give an interference note of 1,000. Should either frequency vary one hundredth of one per cent, the interference note may change from 1,000 to 4,000. Practically when working with frequencies of this order the interference note varies so rapidly and to such an extent with the small variations of frequency which take place that the signals are unreadable.

In a new method devised by C. S. Franklin, the frequency of the local oscillations is varied by a small percentage, regularly and in a continuous manner. This may be done by arranging in the local generator a rotating condenser which consists partly of segments arranged on a rotating disc or cylinder, so that the capacity varies continually between two limits.

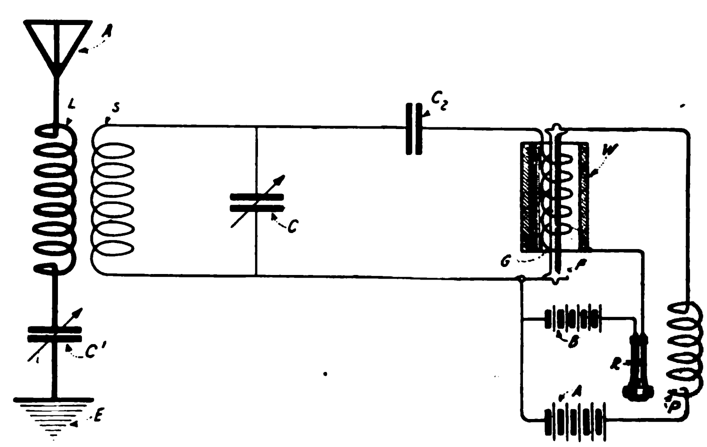
The circuit shown in figure 1 works as follows: Assume the received frequency to be 30,000,000 and the local generator arranged to give a 30,000,000 frequency with variations of a half per cent above and below this, 1,000 times per second, produced by the revolving condenser. During reception an interference note is produced which varies from zero to a frequency of 150,000. An audible sound is produced in the telephone only during the time that the interference note is varying through the range from about 8,000 to zero and back to 8,000; that is to say, while the interference note is within audible limits. The period occupied by this range is so short that only a "click" occurs in the telephone for every variation between the above limits of the frequency of the local oscillator. As, however, this variation occurs 1,000 times per second, a clear note having a frequency of 1,000 per second is heard whenever signals are received.

A receiver for short waves is thus obtained which has the great sensitiveness of the interference receiver, but is independent of very small variations in frequency either in the received waves or in the local oscillator.

De Forest Air Audion

LEE DE FOREST now claims that it is possible to receive radio telegraphic signals by means of a thermionic detector which operates in the open air. In the diagram figure 1, W is a plate which surrounds both the grid and filament electrodes. R is a receiving telephone connected in series with the B battery as in the usual circuits for the three electrode valve. G is the grid electrode which is wound around the filament F, which is a Nernst glower energized by an "A" battery with an impedance coil P in series.

The operating characteristics of this oscillation detector have not been disclosed, but will no doubt be forthcoming in the near future.



Circuit of connections for the De Forest Air Audion

A Summer on the Great Lakes

Some First Impressions of a Novice In Commercial Wireless Operating

By Julian K. Henney

I—Mal de Mer

AS I sit here by an open window listening to the deep-throated blasts of the first freighters of the season, I cannot help but think of the pleasant summer I spent on the Great Lakes last year. The thought comes to me that after all has been said and done, the best positions in the world are not tnose that have the highest salaries attached to them, but those which bring the greatest amount of pleasure and satisfaction to the men who hold them. Personally, I believe that right now I should much rather be a radio operator on the ugliest freighter in the world with the ordinary wireless man's salary, than the president of Germany or the Great Mogul of Hindustan, with the accompanying millions and minions. In fact, I should rather be boss over one measly bellhop than commander-in-chief of an army that was only looking for a chance to put the transformer terminals around my neck. This, however, is entirely a personal opinion and has little to do with the recital of my experiences on the Great Lakes.

After several days of waiting at the Marconi offices in Cleveland, I was assigned to the Juniata with Watson Snell as partner. I knew in advance that the Juniata was a pretty ship and the run from Buffalo to Duluth one of the longest on the lakes, so I was rather elated at being placed as I was. Snell had been on the same steamer the season before, so I imagined we would soon get acquainted with the officers and crew.

We did . . . and quite suddenly too.

We started on the first of July for Buffalo, where we were to board the steamer which left on the second. Both of us were not sorry to get started, incidentally, for the tariff on board and rooms in Cleveland is slightly higher than on shipboard; so as soon as our passports to Buffalo had been issued, we lost no time in getting to the Seeandbee.

We had first, of course, carefully stowed away our tickets in the unhandiest possible pockets, received our death certificates—as the operator terms his insurance policy—our water front passes, a letter of introduction to the skipper of the Juniata, several words of advice from the traffic manager and the superintendent of the company, supplemented with orders to be careful about jamming the new navy men. With this equipment we started for the steamer, prepared to spend a pleasant evening on the way to Buffalo where our "six on and six off" started in earnest. Learning that we were to sleep in the radio man's bunk while he was on duty during the night, both Snell and myself had visions of a wonderful snooze while the great side-wheeler rushed us toward our own steamer.

All day long the wind had been whipping the shallow waters of Lake Erie into one of those choppy seas which are characteristic of this body of water, especially in the early part of July. The waves could be heard coming over the breakwater as we lugged our grips to the dock where the Seeandbee was tied up, and it was with the greatest of difficulty that Snell managed to keep his straw hat firmly anchored to his head. As gusts of wind tore past my singing ears and stinging cheeks, I looked out of the corner of my eyes—at intervals when the tears were not running out of them like a miniature St. Mary's Rapids—to see if that straw bonnet was still jauntily perched on the side of my worthy partner's head. This reconnaissance work was fascinating. For the hat stuck to its perch marvelously, much to my enjoyment at the time, but to my later embarassment. About every ten steps Watson would come to a groaning halt, methodically set down his suitcase, his kodak and his mandolin, thus freeing a hand to pound the hat down over his ears, while I trudged valiantly onward toward the pier with a half-ton hand trunk to impede locomotion.

But all thought of high seas, higher wind, and worries in general, left our minds as we lugged our dunnage aboard the Seeandbee and up a half-dozen flights of stairs. We walked up one corridor and down the other, vainly seeking the radio room. Our luggage became heavier and heavier. Several aeons, or ages, or something passed; but at last a kindly disposed bellboy pointed out the locked door of the wireless room. We deposited our paraphernalia outside the entrance, and waited. After sitting on the madolin and the hand trunk, respectively, for a half-hour, Snell and I decided that the radio man was not coming, and that we would have to sleep on the floor or invest three-fifty in a stateroom. Upon reflection, however, neither scheme appealed as being particularly practical; so we sat and waited.

While thus in repose, tied up to the mandolin and the traveling bag, we could fully appreciate that the wind was whistling overhead in the rigging, and occasionally we would hear a sickly groan as the steamer leaned over and rubbed against the pier. We were still inside the breakwater, but whenever a hard gust struck the vessel she lurched and strained ominously at her hawsers. . . . We began to wonder if it would not be better to go by train to Buffalo, and not take chances on the Seeandbee's going down. . . .

With each rise and fall of the ship under us, we looked —not at each other—but out of the porthole, estimating the desirability of the New York Central as a common carrier, rather than the Cleveland and Buffalo Transit Company. But we sat on mandolin and traveling bag, and waited. It was here that Watson told me he intended to learn to play the staunch musical instrument, and he also confided that he had paid as much as a dollar and a half for the affair. Potentially, it was a good investment, for when I later heard him learning to play it, I offered him ten dollars to throw it and his musical aspirations overboard. He refused; doubtless reflecting upon the mandolin's one-time utility as a mourner's bench.

Nevertheless, about ten minutes before sailing time the radio operator appeared, and strange to say he seemed quite pleased to see us. I forget his name, so the designation of Jones will have to serve the purpose of this narrative.

Jones was a pretty good chap. He was not specially enthusiastic about us sleeping in his bunk, but he did not object. He eyed our impedimentia with a wary eye, but my pardner and I were nothing daunted. We were to sleep in his bunk; we intended to stow our stuff in the

wireless room; and there we were; there could be no arguing about it. Jones could hardly have been pleased to hear what he soon learned: that I was from Western Reserve University. He came from Case School, my college's mortal enemy, so I looked for a rehearsal of the Thanksgiving game on the spot. But, as I say, Jones was a pretty good chap.

At eight o'clock the steamer cast off, and soon we were on our way down the waterfront, inside the long breakwater that protects Cleveland's shipping from the choppy seas of Lake Erie. I had been rather apprehensive as to what would happen when we got out in the open, and my fears were realized with interest as soon as the Seeandbee poked her nose into the gale.

A huge roller took us off the port bow, twisting the ship from stem to stern; a gust of wind took a slap at the upper works at the same time. The vessel rolled over with a snap; I rolled to the floor; Snell rammed his head into the bunk, and Jones got white around the mouth.

When a fair equilibrium had been established the long-looked-for question came forth.

"Do you fellows get sick?" inquired Jones, and there was a slight suggestion of loftiness in his voice.

I was fully prepared to answer. I would play safe. "Well, I never have yet," was my reply.

Snell adopted a superior tone. "Oh no, not me," he replied. "I spent all last summer on the Lakes and never even felt bad. I guess a little thing like this won't bother me." His manner reminded me of how his hat had stuck on his head with a sort of summery jauntiness that riled one all up. We were quiet for some time, trying to adjust ourselves to the twisting of the floor under our feet. Finally: "How does it feel to be sick, I wonder," speculated Jones.

"I don't really know," said Snell, "that is, from experience; but they say you feel kind of hollow down in your hold, and then in the galley it feels . . . well your dinner kind of. . . . I believe I'll turn in and get some sleep!"

Snell made a motion as if to enter the bunkroom door, but catching my eye, decided to stick around. Jones kept up his searching investigation into the subject of seasickness. He might have been intending to write a book about it from the interest he showed in Snell's answers.

"The mate tells me that even skippers and mates get sick some times when it is rough," was one of Jones' observations which I recall.

"Yes I've seen it so rough that even the Old Man had to stay in bed," agreed Snell. "But this little sea tonight is nothing to what you get in Lake Superior." I felt that this was a jab at me. "Are you having any success with the outfit this year? I used to hear the spark up North once in a while."

"Why yes, I guess so," said Jones. "You see I've only made a few trips. I never got sick yet. But then it has never been so rough before."

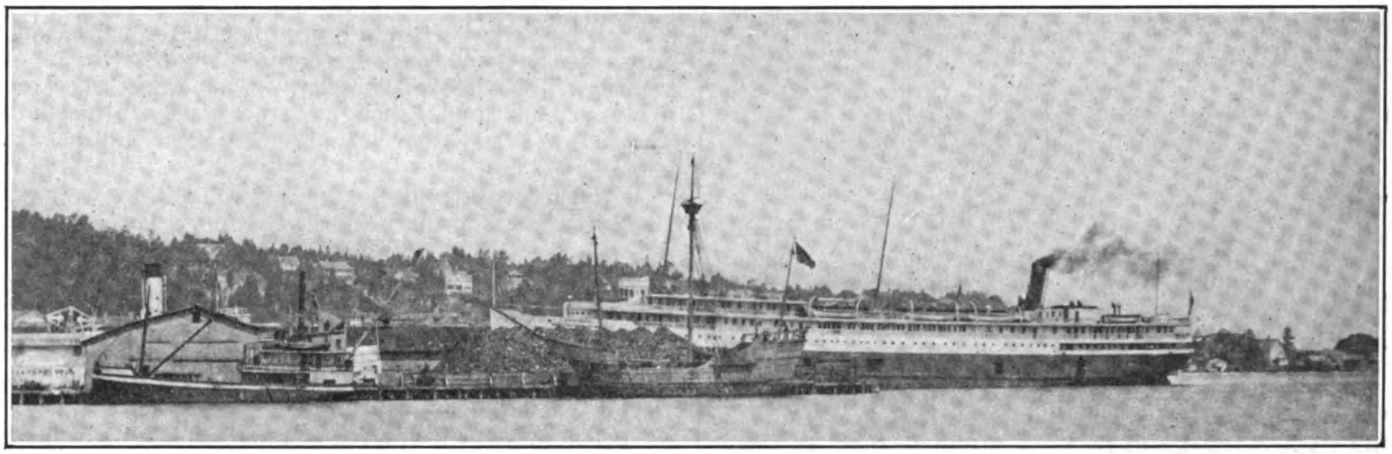
"Do you know Dietsch of the Detroit Third?" Snell tried again to change the subject.

"Yep, Dietsch has a pretty good fist, hasn't he? . . . You know, I'd hate to get sick on this tub. . . . What is a good thing to do for seasickness?"

About this time my mind's eye began to open. It became evident that the great wireless operator of the wonderful ship Seeandbee, the man who held the lives of all the ship's passengers in his hand, was worrying about something.

I shall never forget the little tableau which was then enacted in the radio cabin of the huge sidewheeler. Jones was at one end of the long room, perched upon the top of a high stool, the receivers over his ears, trying his level best to stick on the seat and to appear unconcerned. All his energy was needed to keep from sliding off on the floor with each lurch of the vessel, and he was continually sticking out an arm or leg to hold himself from the opposite wall. Snell stood in the doorway to the bunk room with a queer look in his eyes, one of which I could now interpret. I sat at the far end of the room in the dark, listening to the learned discourse on an ailment the existence of which, tradition records, has never been voluntarily admitted by those who acquired it. That night I discovered the only real preventative for the dread malady. I sat in the one chair that did not wobble and which had

Dark clouds sweeping by made us fully appreciate that the wind was whistling overhead in the rigging



The old and the new furnished a contrast when one of the massive modern Lake steamers nosed in behind a replica of the Santa Maria, the ship of Christopher Columbus

arms, my feet cocked up on the end of the operating table, my head resting on the back of the chair. In this position my body made a large V, with my "hold," as Snell called it, clear at the bottom. I was able to keep from falling on the floor at each lurch of the ship, and after a while I discovered that I did not observe that queer "elevator feeling" as the vessel rose and fell with the waves. I really felt fine, and was beginning to enjoy the affair to the limit. Catching Watson's eye, I nodded that I was on to his curves and immediately began to take an active part in the discussion.

"By the way, Jones, old man, you don't feel bad?" I asked.

"No indeed! Do you?" he replied. Then he added: I —I don't look sick, do I? Of course I could turn in if I got sick. I don't have to stay on the job if I am not able. I could turn in for a while and then—"

"Aw, you fellows can this 'sick' business! You make me tired! Use a little domestic science—" Snell was evidently rattled—"Why do you talk about it? If you're going to get sick go ahead; but quit thinking about it. Just because you feel kind of funny in the stomach is no sign—Ha, ha! Guess I'll turn in and get some sleep."

Snell turned again toward the bunks and I thought for a minute that he was going to desert me. But he had a new thought. Blandly, he asked if I were hungry. I immediately suggested that the three of us go down to the buffet and get something to eat. Jones looked horrified.

"Oh no, I can't leave the outfit," said the radio man. "I'd like to go, but something might happen."

So Snell and I made our way down to the lower deck and aft to where the buffet held forth with everything under the sun that was not good for one to eat. By holding on to the rail around the counter we managed to put down several shredded wheats and some coffee. A portly gentleman then staggered in and devoured a sardine sandwich and a bottle of ginger ale. We decided that the combination was the very thing for our friend up on top, and soon after we returned to the scene of action, properly equipped.

When we first glanced through the door the Case man who had turned wireless operator had his head on the table, pillowed in his arms. Snell coughed. Immediately, I opened up thus:

"What's matter, old man? Not sick in a little sea *like this are* you?"

"Nope," was Jones' energetic response. "I'm feeling a little sleepy, tho. And I can hear anything that comes in by putting on the receivers once in a while. It really isn't necessary to listen in all the time."

Snell turned to me. "By George, Henney," he volunteered. "I believe those bellhops down below were sick. Did you notice how sleepy they were?" He was quick to follow up this new avenue of attack. "Sleepiness is the first symptom, you know," he added seriously.

Poor Jones fell for the bait at once. "Is that right? But then, I haven't been getting much sleep lately. Guess that's why I am drowsy. How were the bellboys acting? Did you say they were sleepy?"

During the interchange, my friend Watson and I had firmly seated ourselves in the two good chairs, our feet high up in the air and our bodies in that comfortable and secure V position which I had discovered and passed on to Snell. But the poor Case man, he of the wonderful ship Seeandbee, was perched high up in the air on a rickety, swaying stool, the light of the lamp hanging over the operating table making clear every expression of his countenance. His feet were hitched in the rungs of the stool on which he was so precariously seated, and although he tried to conceal it, we could see that his hands were spasmodically twisting and turning, one to his stomach and the other to his mouth, as if he was expecting something. He tried to adjust his apparatus as a blind, but invariably they would return, respectively, to midsection and mouth. It was plain to see that the pangs of *mal de mer* were beginning to have their effect.

"You bet those bellhops are some sleepy." I hastened to assure him. "And you ought to see them rubbing their stomachs. You'd think there was static in 'em."

The hand came away from his waitsline with a jerk so strong that it knocked the detector out of adjustment. By the time he had this fixed Snell was ready with another frontal attack.

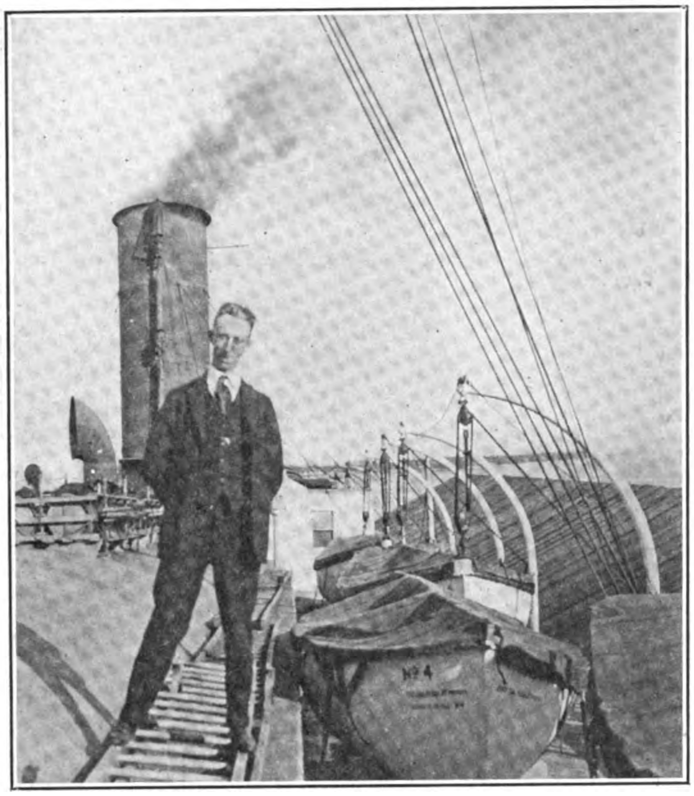
His voice took on a reminiscent strain. "I remember one time I was up in Lake Superior. It was blowin' something awful—just about like this, in fact—and the bellhops on board had been eating all kinds of stuff. They had turned out to see the fair at Houghton and all the candy, peanuts and popcorn in the place came back inside them. Well—would you believe it?—every last one of these fool kids got sicker 'n dogs. And the funny thing about it was the way they got sleepy just before they ran for the rail. They kept gettin' sleepier 'n sleepier, 'n they were all rubbin' their——"

"Wait a minute!" wailed Jones. "Somebody's calling me."

He pretended to listen awhile for signals. Then he announced that he must have been mistaken.

"I guess it was just—just static. This roll kind' a goes to my head. It's not likely that I'm going to get sick but you guys had better go to bed. It's blowing fit to kill outside, and I don't want to be bothered with any sick fellows 'round here."

Snell and I both assured him that we were over our sleepiness. "I wouldn't go to bed for the world now," said Snell. "All this reminds me of that night on Lake Superior. Yep. The swell was just about as bad as this



The author, who engagingly tells why he would rather be a wireless operator than the president of Germany or the Great Mogul of Hindustan

—it's rolling like thunder, do you know it, Henney?" He shifted his gaze. "Well those bellhops had been eating mince pie and drinking pink circus lemonade, and all that sort of stuff you know, and—

"By the way, Jones, feeling sick? That light makes you look kind of pale."

I felt it was up to me to say something. "If you want to turn in for a while old man," I began in sympathetic tones, "Watson and I'll be glad to stay on the job." This offer to stay up for him was very magnanimous, and Snell smiled approval. "Go and stretch out for a while," I added soothingly. "That's the best thing for seasickness. Just go to sleep and we'll have a good time sitting up while you are getting better."

Snell hitched his chair a little closer to the bunk room door, effectively closing the entrance to that haven of security. Jones looked longingly at the white sheet on the lower bunk; and, I thought, rather warily at the white wash bowl in the corner behind Snell's back. But he was game.

"I feel a lot better now. I guess I'm getting over my sleepiness. Strange how long this storm stays on, isn't it?"

We had been out all of three hours; which can be quite a long time from some viewpoints. Jones looked up miserably at the lamp swinging back and forth with the roll of the ship, and then added as if he had just thought of it. "If I get feeling bad, I'll let you fellows stay on duty for me."

Snell's voice took up its monotone. "Well sir, those poor bellhops were about the sickest bunch of fellows I ever saw. They had been eating all kinds of stuff down at the buffet and"—Snell's story always started and ended with the eats—"and the stuff simply wouldn't—. You haven't been eating anything, have you, old man?"

"Only a little popcorn this afternoon," came in a weak voice from the stool. "And I drank some buttermilk at Thompson's just before I left tonight. That ought to be all right, hadn't it?"

I looked at him with an expression of shocked amazement. Snell opened his mouth as tho to say something, and then closed it as if words simply couldn't express his horror. Jones paled.

"You don't mean to say that you put that combination in your stomach!" I gasped. "Acid and starch! Why man alive that's enough to kill you on land, let alone on board ship in a gale like this. Thompson's buttermilk! Did you hear that Watson? That rotten manufactured stuff with the microbes floating around on top with their toes up in the air! It's a good thing he didn't load up like that guy in the buffet, eh Snell? Just think of a nice smelly sardine sandwich and a bottle of ginger ale added to that mess—"

I was interrupted by a despairing groan from the top of the stool.

"Oh Gawd!"

Jones slipped from the stool, made a staggering dive for the door, missed Snell by a half inch, and a few minutes later we heard him plump down on the bunk.

Mal de mer had conquered.

Ensign Rodd

He Got Across

Something About Ensign Rodd, First Wireless Operator to Fly Across the Atlantic

TO Ensign Herbert C. Rodd, a former amateur of Cleveland, Ohio, and an ex-Marconi operator who enlisted in the Naval Reserve shortly after the United States entered the war, fell the unique distinction of manipulating the wireless apparatus on America's flying boat NC-4, the first craft to span the Atlantic by the air route. As the nation rejoiced on May 27th that the realization of a dream centuries old had a material basis in fact, universal congratulation was extended by wireless workers to the young man who had successfully maintained communication on the aircraft during its flight across the wide ocean.

That a former amateur should have been selected for this position of great responsibility is an additional fact to establish the importance of extensive development of the experimental field in wireless. Once again it is emphasized how much was contributed to the Navy's success by the civilians called to its ranks in the emergency, and this incident should be viewed as a climax to achievement, setting at rest for all time proposals looking for government ownership sponsored by Naval officials.

General public recognition has been given to the aerodynamic aspects of the great flight and it is looked upon as a gloriously fitting triumph for the United States, a country which produced the Wright brothers, the first to achieve mechanical flight in a heavier-than-air machine; also another American, Glenn Curtiss, first to make the airplane a water as well as an air machine. Little attention has been given, however, to the equally significant fact that the country of Ensign Rodd was the first to develop and encourage amateur wireless in a broad way and place it on a scientific basis. Now that it is generally recognized that the success of the flight was in a large measure due to the perfection of communication arrangements, it is equally fitting that the event be celebrated as a triumph for American wireless men.

As to the particular individual who handled the key: he is a typical American amateur in every respect. His mother, in commenting on his achievement, voiced in a sentence a biography which might be applied to the many thousands who are daily engaged in wireless experimentation. Mrs. Rodd said, "Ever since he was a boy, my son has been experimenting with electrical devices, endeavoring to improve them."

He joined the Marconi service at the opening of the Great Lakes navigation season, seven years ago. His first assignment was on the steamer Eastland, and during 1913 and 1914 he served as senior operator on the Octorara. He was then transferred to the Lakeland, on which vessel he won recognition as an S. O. S. celebrity. His vessel ran on the rocks off the port of Alpena, November 10th, 1914, during a gale and heavy snow storm. Rodd sent out the distress signals and established communication with the Marconi station at Cleveland, from which the wrecking tug Favorite was dispatched to the Lakeland's assistance. The young operator maintained constant communication with the wrecking tug until she arrived, and then joined the crew in lightening her cargo to the end that, with the assistance of the tug and life saving crew, the vessel was safely towed to Port Huron, Ohio.

The following season Rodd became operator at the Marconi station in Detroit, Michigan, remaining there for several months and then accepting a transfer to the yacht Nakomis. He remained on this vessel until the close of navigation in 1916.

In the Spring of 1917 he heeded the call to arms and entered the Naval Reserve as Electrician, First-Class. His first assignment detailed him back to the station at Detroit, and a later transfer brought him to the Marconi station in Cleveland. When a few months had elapsed, he moved on to the Marconi station at Calumet, Michigan, where he took charge of the equipment and received a rating as Chief Petty Officer. His ability had then attracted attention, and he was called to a naval station at Great Lakes, Illinois, where he was placed in the laboratory and assisted in the construction of the ground station and distant control station at this point. He was commissioned an Ensign in the Fall of 1918 and was transferred to Norfolk, Virginia, where he displayed such unusual radio ability that selection fell upon him as radio officer of the NC-4.

At It Again

After two years of painful suspension of activities the wireless amateur is again on the job. Above, a New York Y. M. C. A. enthusiast is making the familiar adjustments inseparably associated with the joy of "listening in"

On the left is A. W. Nelson of Montana longingly cuddling a radio phone transmitter

Press Ill. Svce.

And here, the most familiar of sights—the old aerial going up! The particular amateurs are Barber and Terleph of Richmond Hill, N. Y., but the task engaged in is applicable to ary locality in these broad United States

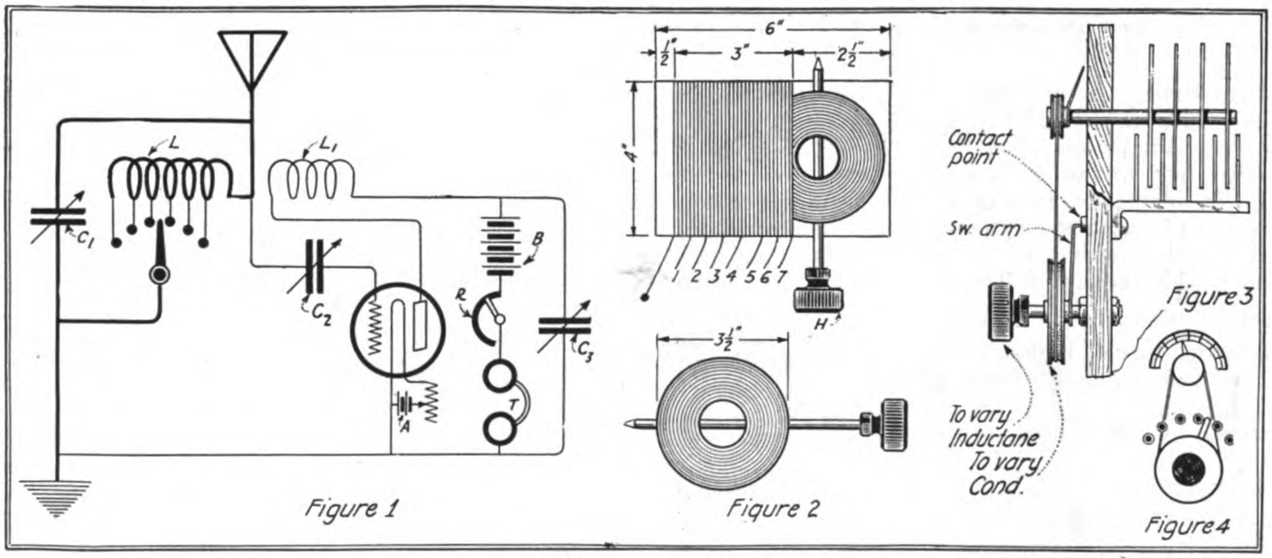
EXPERIMENTERS' WORLD

Views of readers on subjects and specific problems they would like to have discussed in this department will be appreciated by the Editor

Efficient Receiving Apparatus and Experiments with Electrostatic Coupling

By E. T. Jones

THE receiving circuit about to be disclosed is superior to the usual run of circuits presented by various experimenters. One of the principal features is that the valve may be made to oscillate steadily at frequencies corresponding to waves as low as 150 meters. In fact, the circuit functions well at wave lengths between 150 and 3,000 meters, but for still longer waves the more common circuits are preferred.



Drawings showing the elementary circuit, the tuning inductance and end turn switch, respectively

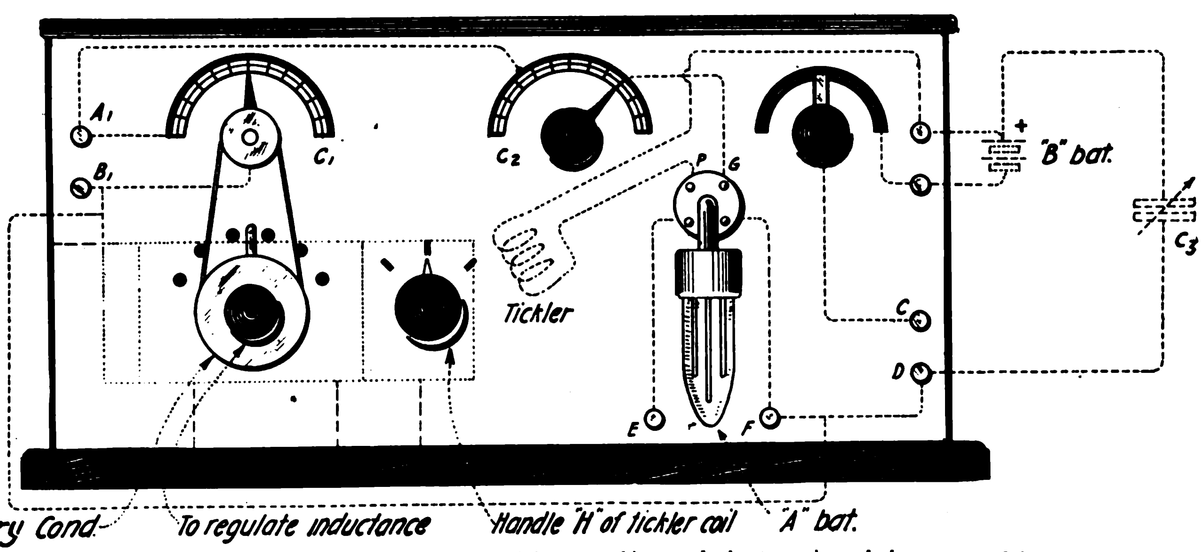


Figure 5—Showing complete apparatus mounted in one cabinet and phantom view of the tuner and its connections

Many of the several hundred circuits shown heretofore have the great disadvantage of introducing too much inductance in the associated circuits to operate on short wave lengths. In the following diagrams this is overcome in a way that improves the overall efficiency.

Figure 1 is an elementary circuit; L, constitutes the tuning inductance, and L-1 the tickler coil. It will be shown later that instead of providing two coils for the tickler, the primary is mounted in the end of the tuning inductance and caused to rotate in much the same manner as the movable coil in a variometer.

C-1 is the usual shunt variable capacity across the tuning inductance L. It is to be noted that no primary inductance is employed, and the losses which would be present in capactive or magnetic coupling are eliminated. In fact it was noticed that approxi-

mately twice the strength of signal was obtained when using the connections shown; and quite contrary to the belief that such a circuit would fur-

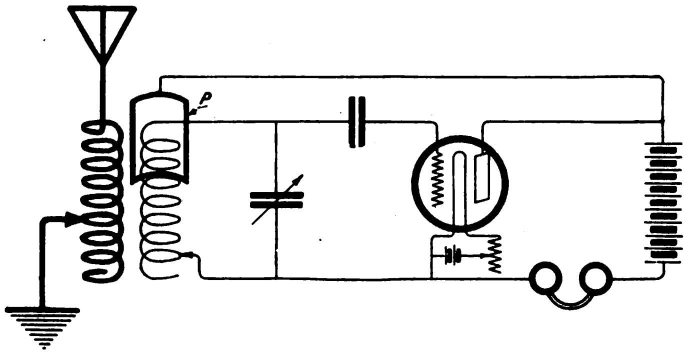


Figure 6—Showing plate circuit electrostatically coupled to the secondary

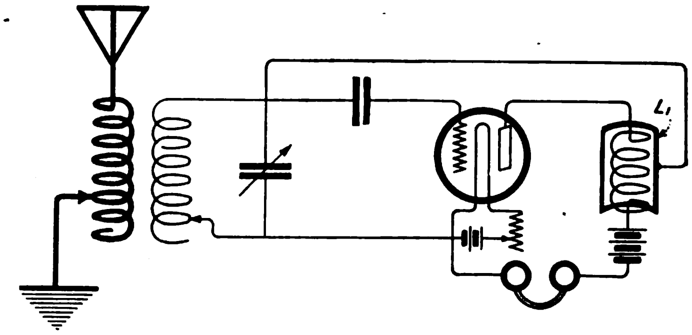


Figure 8—A modified method of obtaining electrostatic regenerative coupling

nish broad tuning, it was found exceptionally critical. This makes the tuning a very simple operation, it only being necessary to cut in a certain amount of inductance and vary the condenser until maximum response is had. A detailed outline of the construction of this receiver follows:

The Tuning Inductance

A cardboard tube 4" in diameter and 6" long has a 3" winding of one layer of No. 28 S.C.C. wire. Taps are taken off as shown by the numbers in figure 2, ¼"-¼"-½"-½"-½"-½"-½", which makes a total winding of 3".

The Tickler

The tickler primary is wound on a frame 3½" in diameter pivoted as shown and placed in inductive relation with the secondary inductance, the degree being controlled by moving the handle H. It is wound with the same size wire—No. 28 S.C.C.—for a space of ½". A very good form can be

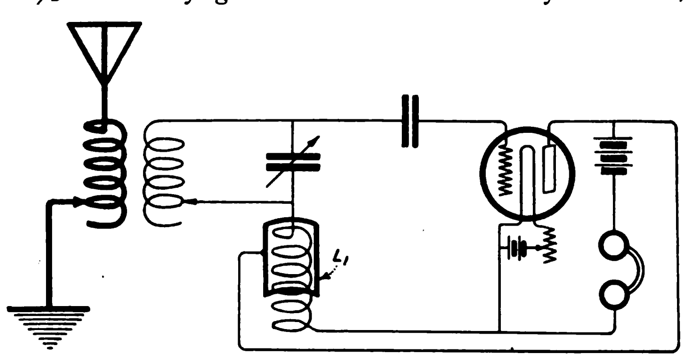


Figure 7—Another method of coupling electrostatically the plate to the secondary-grid circuit

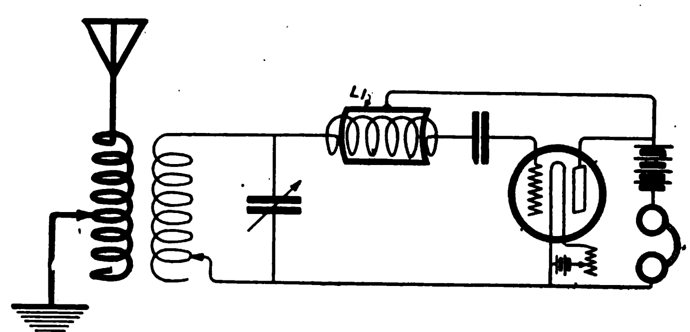


Figure 9—Another form of coupling showing the coupling plate connected to the plate of the audion

made of pasteboard tubing instead of the wooden form.

Any of the various forms of end turn switches can be provided. The design was purposely left out here for the sake of simplicity. All that is necessary after the completion of this inductance is to have a variable condenser mounted in the same cabinet as shown; and in order to simplify the tuning, the arrangement shown below is recommended.

This arrangement consists principally of having the condenser geared by pulleys to the handle of the inductance switch as shown in figures 3 and 4. The pulley mounted on the latter is made to move easily upon the shaft of said switch; this makes it unnecessary to use both hands when tuning, leaving one hand free for manipulation of the oscillating circuits.

It is best to mount the above apparatus in one panel separate from the oscillating circuits because if it is desired to change over from the short wave receiver to a long wave set, it can be accomplished by the use of a double pole double throw switch.

But for those desiring to put the complete apparatus in one cabinet the following details regarding the apparatus as shown mounted in the drawing of figure 5 will be of value. As therein indicated, the condenser is mounted at the top of the left hand side of the panel and just under it, the inductance coil, the aerial and ground connections being made to the binding posts A-1 and B-1. The tickler, previously described, is mounted so that its handle H protrudes outside of the panel.

The right hand side of the cabinet shows the audion adapter, the B battery resistance and the telephones, which are to be connected at C and D. The position of the grid condenser is also shown.

Figure 5 shows a phantom view of the tuner and its connections. Condenser C-1 is shunted across the tuning inductance and condenser C-2 is connected in series with the grid of the audion and the aerial connection A-1. R is the high resistance "B" battery regulator and C, D are the telephone terminals. The A battery or filament battery is connected to the terminals marked E, F. No dimensions are given owing to the fact that the condenser containers vary in size. Any experimenter interested in long distance amateur short wave reception cannot fail to investigate the merits of this circuit, for in addition to giving loud signals, it affords a notable degree of selectivity.

With this type of circuit one is not restricted to the use of very small antennae. By inserting a variable condenser in series with the antenna, if too large for the reception of 200 meter wave lengths, the strength of the signal is not decreased and in some cases it was found to improve the strength, probably due to the fact that the condenser tended to alter the voltage distribution so that a very high E.M.F. was impressed upon the grid of the tube.

Exceptional results were had with an antenna 60 feet long of four wires, spaced 4 feet apart. One supporting mast was 60 feet high, the other 25 feet high.

Some Experiments with Electrostatic Regenerative Coupling

A method of coupling valve circuits electrostatically for various purposes has been described in a former patent by Bucher. I have found certain forms of his method of capacitive coupling to

be very practical in oscillating tube circuits.

Figure 6 shows the plate circuit electrostatically coupled to the secondary. This is accomplished by bringing the metallic semi-circular plate P in proximity to the end of the secondary winding which protrudes out of the primary. Very good and valuable results were secured with this arrangement. The plate P has a critical position in respect to its distance from the secondary windings for each change of wave length, being closer for short waves and farther away for long waves. The plate P must be fitted with a long insulated handle because, due to the coupling between the body and the coil, the presence of the body has a marked effect on the oscillating period of the circuits.

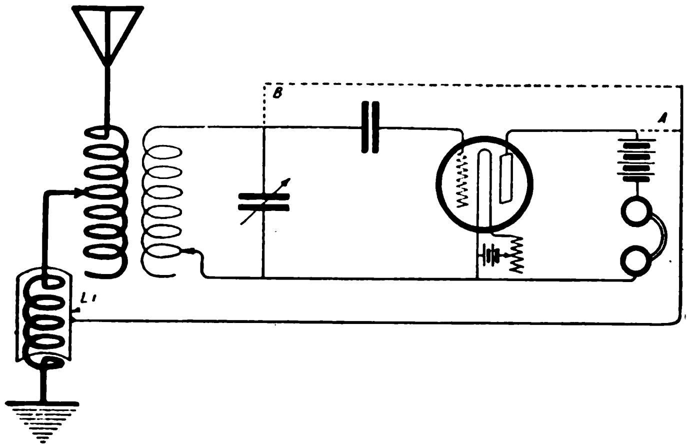


Figure 10—Electrostatic coupling obtained by connecting the coil L-1 in the primary ground lead and the coupling plate to plate circuit of the audion. Very efficient for long waves

Figure 7 shows another method of coupling electrostatically the plate to the secondary-grid circuit. Here the small inductance L-1 is inserted as shown and the plate P brought in close relation thereto.

Figure 8 indicates a modified method of obtaining electrostatic regenerative coupling. The plate P is connected to one side of the grid condenser and the small coil L-1 is connected in the plate circuit as shown. The coupling is varied as before by increasing or decreasing the distance between the plate and the coil L-1. This circuit gives as good results as the two aforementioned. The circuit of figure 9 is particularly useful for short waves.

Figure 10 shows still another form of electrostatic coupling. Although this circuit failed to function on short waves, it gave very good results on the longer waves. The coil L-1 is connected in the primary ground lead, and the plate to the plate circuit of the audion. On short waves such as 600 meters the plate had no effect, but after getting up to 5,500 and 8,000 meters, it required a very critical adjustment. As shown by the dotted lines two connections were tried, but the best results were obtained when it was connected to A.

Figure 9 shows another method which gave very good results on short wave lengths in the region of 200 meters and is substantially the same as figure 7. The plate P was connected to the plate of the audion and electrostatically coupled to the inductance L-1 connected in the grid circuit as shown.

This method of electrostatic coupling certainly has a wide range of applications in connection with audion regenerative circuits, and it is well worth one's time to dig in and see what is in store for the wireless world at large.

Suggestion for Prize Contest AUGUST Wireless Age

We will pay the usual prizes of $10, $5 and $3, in addition to our regular space rates, to the three contributors who send us the best manuscripts on the following subject:

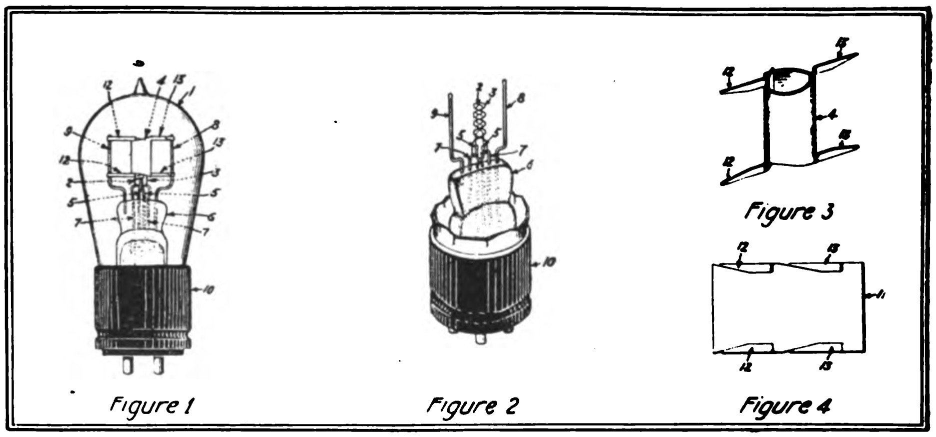
"What do you consider to be the best circuit for undamped wave reception at wave lengths from 4,000 to 18,000 meters and what should be the dimensions of all tuning coils with the average antenna?"

Vacuum Tube Construction

H. J. NOLTE of Schenectady, N. Y., has shown the design of the internal structure of a three electrode vacuum tube as indicated in the drawings, figures 1, 2, 3 and 4. Figure 1 is a view of the completed pliotron; figure 2 is a view of the pliotron with the bulb and the anode broken away; figure 3 is a view of the anode and figure 4 a sketch of a metal sheet from which the anode is constructed and which shows how the supporting strips are cut away.

The completed pliotron comprises an evacuated bulb 1 within which are located the cathode 2 in the form of a coil filament which is preferably of tungsten, a grid 3 in the form of a coil wire surrounding the cathode and a cylindrical anode 4 surrounding the grid.

Leading-in conductors 5 which are sealed through the stem 6 supply current to the cathode and leading-in conductors 7 which are also sealed to the stem 6 supply current to the grid. The anode 4 is supported by two arms 8 and 9 both of which are sealed into the stem 6. Arm 8 extends through stem 6 and serves to carry the anode current.



Drawings showing the complete pliotron; view of pliotron with bulb and anode removed and finally the anode complete and method of construction

The anode is constructed of a rectangular sheet of metal as shown in figure 4. From each side of this sheet, strips of metal 12 and 13 are partly cut away in the manner indicated. The sheet is then bent into cylindrical form and the strips 12 and 13 are bent away from the cylinder so as to extend in diametrically opposite directions therefrom as indicated in figure 3. The ends of the strips are then wound around the supporting arm 8 and 9 as shown in figure 1 and welded thereto.

Controlling the "B" Battery of a Vacuum Tube

THE connections shown in the accompanying drawing for "easing up" the "B" battery control of vacuum tubes may be of interest to amateurs who are troubled with critical potentiometer adjustments. A 400 ohm potentiometer shunted across the last two or three cells gives a very fine control of the local E.M.F. It has the further advantage that it does not run down the entire B battery which would be the case if a potentiometer of such low resistance were shunted across all the cells. It will be noticed in the upper part of the drawing that an end cell control of the plate voltage is provided, a three point switch being connected to the two end cells to permit them being cut in or out.

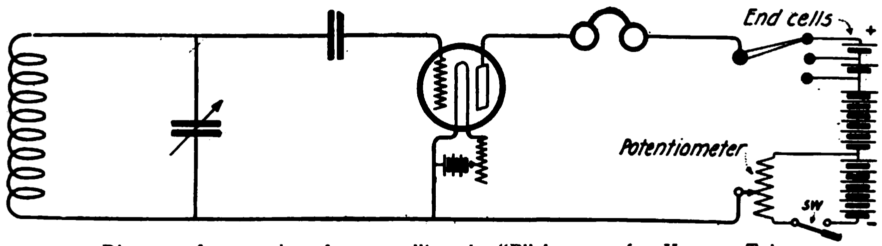


Diagram of connections for controlling the "B" battery of a Vacuum Tube

I have used this diagram of connections with great success.

LOUIS FUNKE—*New Jersey.*

Contest Winners for July

The May WIRELESS AGE subject for discussion was: "To what extent do you believe that wireless telephony will take the place of wireless telegraphy in amateur communications?" The usual prizes have been awarded to the writers of the following articles.

First Prize—Will It Be "Hello" or Telegraphic Buzzes

WE are asked to what extent in the future, the wireless telephone will take the place of the wireless telegraph. This question causes us to regret our lack of the gift of prophecy, for here indeed is a job for a wiseacre. The first thought that occurs to one in the consideration of this question is that everybody can talk, but that comparatively few can send and receive wireless messages; therefore, we are likely to conclude that the amateur will be in haste to abandon the crackling telegraph for the still, small voice of the radiophone. But there are considerations that will make many of us pause. A very little money will install a simple wireless telegraph set. If one merely wishes to receive, almost any piece of wire sticking up in the air a few feet will serve as an aerial. One can easily make a tuning coil, a fixed condenser and a detector stand. A pair of telephones will cost about five dollars, and a bit of galena a few cents. With this equipment one can hear stations hundreds of miles distant, perhaps a thousand.

Of course even the smallest and simplest sending outfit costs much more, but almost any young man of enterprise, industry and ingenuity is able to install a complete set if he wishes to do so. On the other hand, the radiophone is too costly for the average amateur. I have scarcely any idea what a transmitter, good for a hundred miles, would cost, but I do recall that I once saw a transmitter offered for $375, but it would transmit only seven miles. So, looking at it from a pecuniary standpoint, it does not seem probable that the amateur as we have known him in the past will plunge very deeply into wireless telephony.

Then it seems to me that to those who have wireless telegraph outfits, the wireless telephone would become a commonplace thing. As before remarked, anybody can talk, but to be an expert telegraphist requires severe, persistent endeavor; and the things that are acquired only by labor and sacrifice are the things that are most valuable to us—things that cannot be handed over the counter for so much money.

But cost is doubtless the chief factor in the question. Leaving cost out of consideration, it is almost idle to speculate. We know that wire telephony has elbowed wire telegraphy to one side to a great extent in the last few years. Perhaps the amateur will follow the line of least resistance, take something that requires but little training and go in for the wireless

telephone as far as the state of his treasury will permit; but it is to be feared that this condition will restrain the enthusiasm of many of us. Of course the high cost of wireless telephony applies only to transmission. Any receiving set equipped with an efficient detector will reproduce the human voice. It is possible that when wireless telephone stations come to be established in all large towns (as they surely will), thousands of amateurs who know nothing of telegraphy will install receiving sets in order to enjoy the wonder of taking from the regions of space an energy that will reproduce words spoken hundreds of miles away. I well remember the surprise, almost terror, with which I suddenly heard a voice coming out of the depths of space as I sat with the telephones on my head one night over two years ago. The mysterious and unknown speaker ended by singing "The Swanee River."

So, to sum the matter up, I should say that the cost will prevent the average amateur having a wireless telephone transmitter, but that when strong transmitting stations are established in the principal places, receiving stations will be numerous. But I hope and predict that the amateurs as a body will not abandon that branch of wireless that requires practice and skill, and whose rewards are only for those who are willing to pay for them by earnest endeavor.

The development of a cheap wireless telephone transmitter may upset my prognostications; but that is just what we amateurs are waiting for—an inexpensive radio telephone set.

S. F. MCCARTNEY—*Pennsylvania.*

Second Prize—Radio Telephony as Regards the Amateur

I AM somewhat "on the fence" in offering a comparison of the ultimate relative value of the wireless telephone and telegraph in amateur communication. Comparing them from the viewpoint of present day progress, I stand in favor of the wireless telegraph, but I see that in the future, wireless telephony may become a very serious competitor of the wireless telegraph. Although the two systems of signaling have points in common, the matter of expense, manipulation, etc., in the two types of apparatus is vastly different.

To my mind, the up-to-date and progressive amateur will be the first to experiment with radio telephony, but it is certain that for a number of years radio telephony will not replace, even partially, radio telegraphy. It must be admitted that radio telephony has advanced rapidly during the war, but the operating characteristics of the wireless telephone have not changed sufficiently to afford it a better position in the eye of the amateur. The wireless telephone necessitates the use of complicated and intricate circuits, and expensive apparatus that is beyond the resources of amateurs of limited means. In fact, one of the first things that must be done to create genuine enthusiasm among amateur experimenters is the production of a cheap wireless telephone set that he may construct or purchase. It is a well known fact that all amateurs are "dabblers" and like to construct their own apparatus. The experimenter can construct all of the apparatus employed in radio telegraphy because of its great simplicity, but this cannot be said of the apparatus used in wireless telephony.

Not only is the construction of the wireless telegraph apparatus less expensive, but the actual building of the apparatus gives experimenters an insight into the fundamental principles of radio and constructional details that tends to make them better informed men. The radio telephone includes so much apparatus that the amateur cannot construct, that he is not likely to attempt to build a set. If radio telephony is to replace, even partially, radio telegraphy in the amateur field, more simple circuits and less expensive instruments must be provided.

There is another point decidedly in favor of the radio telegraph. Surely as long as the amateur can signal 2,000 miles by radio telegraphy, he will never be content to telephone 50 to 100 miles, for after all, it is the range of the radio telegraph that gives the amateur such genuine amusement. If the telephone could be worked as far as the telegraph, my arguments would be just the reverse.

If, in the future, some one provides a wireless telephone transmitter that will permit experimenters to talk several hundred miles at the wave length of 200 meters, then it is apt to prove a serious competitor to the wireless telegraph, but it is very doubtful whether such a set will be produced.

The amateur, having plenty of funds, will undoubtedly construct a short range vacuum tube wireless telephone set to be operated alongside his standard transmitting set, but it is to be doubted whether he would be satisfied with a wireless telephone set alone. I firmly believe that the wireless telegraph set will stay on the "top of the heap" for many years to come.

ARLYN ROSANDER—*Michigan.*

Third Prize—This Experimenter Favors the Wireless Telephone

DURING the war vacuum tube wireless telephone sets were perfected by the allied governments to the point where it became possible to talk a hundred miles or so with an input of less than one kilowatt. Scores of amateurs are preparing to experiment with this new form of communication as soon as permission is given to use their transmitting stations. It is my opinion that the wireless telephone has been improved to such an extent that it may supersede the wireless telegraph in amateur stations.

The radiophone has many advantages over the telegraph and a few disadvantages. Among the advantages, the most important is the fact that one does not need to learn the telegraph code.

The second advantage applies only to amateur transmitters using the rotary or straight spark gaps operated in the open air. Here the wireless telephone, with its absence of the crashing discharge, is much to be preferred to the old type of transmitter, where a blinding flash occurs every time the key is pressed. Due to the comparatively low potentials used in wireless telephony, breakdowns of insulation in the aerial or apparatus are largely eliminated. For the same reason very little leakage from the aerial to the ground will occur when the wireless telephone is used, rendering it less liable to losses of energy.

Another advantage of the vacuum tube radio telephone set is that by inserting a key in the control circuits, it is possible to transmit telegraphic signals as well as the voice. The telegraph signals will carry a greater distance than the voice, making it possible to use the telegraph when operation over long distance is necessary and the voice when considerable correspondence is to be carried on in a short time.

Although telegraphic signals from such sets transmitted by undamped waves can be received only on an oscillating audion circuit, the voice may be heard on any standard wireless receiving set, making it unnecessary for the younger experimenters to go to the expense of building a regenerative vacuum tube receiver.

The only disadvantages of the wireless telephone over the telegraph are the expense, the short range and the precision of adjustment necessary if the telephone is to operate successfully. However, at the rate improvements are being made in the apparatus used in wireless telephony, it will be but a short time until instruments are placed on the market that will be entirely suitable for amateur radiophone stations. A precise adjustment of each complement of a wireless telephone transmitter is required if the set is to be successful. By the help of good books on the subject, any amateur can soon learn to maintain the apparatus in correct adjustment.

We will now consider some of the former uses of wireless telegraphy among amateurs. Before the war, amateurs operated, successfully, a line of radio relay stations, extending in all directions over the country. Hundreds of messages were transmitted every night. Some of these stations in order to get a message to the next station along the line, were obliged to span distances of several hundred miles, especially in the West, where, at some points, suitable amateur stations were few and far between. For this reason, constant and reliable service was not possible at all times, because of atmospherics and QRM.

Several leading amateurs advocated shorter relays, as a solution of the relay problem, but the war stopped all experimenting, so that lines having shorter relays have not yet been tried out. If, in the future, shorter relays become a reality, I believe the wireless telephone will offer a reliable and speedy means of relaying messages. Although the speed of transmission is reduced by having to pass through a greater number of stations, the telephone will make up for that loss, because many more words can be spoken in a given time, over the wireless telephone, than can be transmitted over the wireless telegraph.

Some owners of private stations use their sets to chat with near-by friends, for the mere novelty of sending signals through the air. This class of experimenters will be apt to adopt the wireless telephone more than any because the feat of actually talking through the air will appeal to them as a new toy.

There was some fear for a time that amateur wireless was done for when the President issued the executive order closing all private stations, for the period of the war, and again when anti-amateur legislation was introduced; but instead of discouraging the amateur's efforts, these obstacles seem to have created a new interest in the science, which has been augmented by the numerous inventions and improvements made during the war.

We may conclude that the wireless telephone is capable of replacing the telegraph for nearly all amateur purposes, the exception being stations located at great distance from one another.

J. E. LAW, JR.—*West Virginia.*

The Monthly Service Bulletin of the

NATIONAL WIRELESS ASSOCIATION

Founded to promote the best interests of radio communication among wireless amateurs in America

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A Letter of Appreciation

I WISH to thank you for accepting me as a member of the Association. I also wish to congratulate the N. W. A. on the way they handled the Alexander bill. You may be sure that thousands of amateurs throughout the old U. S. A. are grateful to the N. W. A. for the work accomplished.

I feel that the amateur would have been a thing of the past if the N. W. A. had not stepped up and opened the eyes of Congress to the fact that amateurs are not kids at play, but that they constitute a full-sized man's organization.

I would also like to see the suggestions go through that 9YI suggested in the March bulletin; that is, the matter of State Organization. In an organization of this kind each state could have a get-together meeting once a year which would be of inestimable value. Other state associations have been formed; what is to prevent us doing the same thing?

VICTOR H. CARRUTHERS, *Grace, Idaho.*

A Comparison of the Isolated Instrument and the Panel Transmitter

THE argument whether the panel type or isolated instrument type of wireless transmitter is best suited for the amateur, to my mind, depends upon the use to which they are to be put. One type of amateur uses his set simply for social purposes, and after it is once in operation, it is very seldom altered, but is used constantly to communicate with friends. This type of experimenter rarely carries on extensive experiments and knows little of the theoretical principles of his apparatus. The panel type of transmitter, in the opinion of the writer, is best suited for this amateur since it is compact, less liable to get out of order, is portable and presents a very neat appearance. On the other hand, the man who can truly be called a radio experimenter studies the theory of the different parts of the set, makes changes constantly to correspond with the advancement of the radio art, and also experiments to determine the characteristics of the several instruments used.

Intensive experimenting is not possible unless each instrument is isolated, this being true of all phases of scientific research, whether it be radio, electrical, chemical.

It appears to the writer that a panel type of transmitter would not appeal to the amateur with a scientific turn of mind. Even small changes must be made to satisfy his curiosity. Such experimenters represent the type of man that proved so efficient in the military service during the war.

The Government, at the present time, is utilizing the panel type of transmitter exclusively. Complete sets, up to 1 kw., are being used as one unit, even the motor generator being contained therein. This design has been adopted because it provides for ease of manipulation, quick installation and portability.

The progressive amateur finds that the vacuum tube is replacing the familiar spark gap transmitter as a source of radio frequency currents and its development is most assuredly in its infancy. It would be impracticable to construct a panel transmitter of this type because radical improvements are constantly being made. It is possible that, in a few years, the spark transmitter will be obsolete.

In conclusion, therefore, I believe that, of the two respective types of wireless transmitting sets for amateur use, the isolated instrument type is preferable, first, because the experimental type of wireless enthusiast is decidedly in the majority, and second, because it advances the knowledge of amateurs, and third, it eventually causes less trouble to our Government in the enforcement of the wireless law.

L. R. JEWETT—*Massachusetts.*

Improved Circuit for the Stern's Tube Transmitter and Receiver

By Morton W. Sterns

THE operation of the set I described in the June issue of THE WIRELESS AGE may be considerably improved upon by adding the features shown in the accompanying drawing.

In the first place, the carbon potentiometer now connected in the plate circuit, makes the impedance of the output circuit higher, thereby giving increased efficiency when receiving. It must, however, be shunted out of the circuit when transmitting. The resistance is a 20,000 ohm carbon or graphite potentiometer such as may now be obtained to control the voltage of the "B" battery.

I have added also, a double pole double throw change-over switch to change from "arc" to "spark" reception and a telephone jack for connecting the microphone transmitter in series with the ground lead.

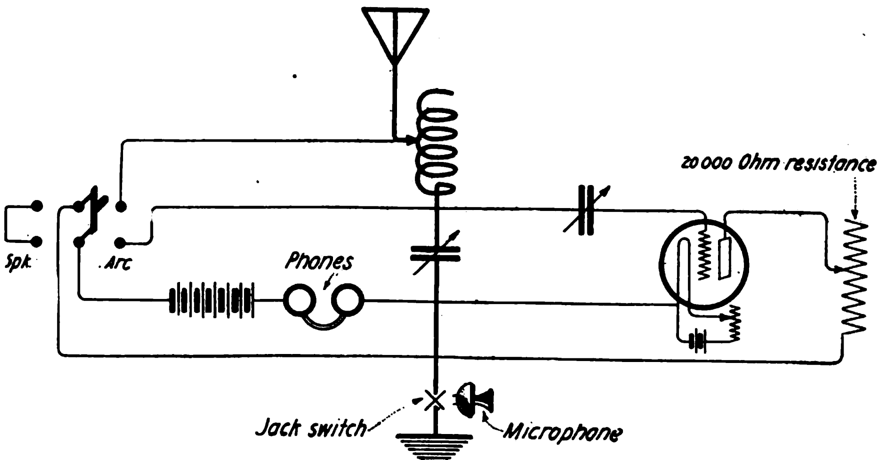

Diagram showing added features in the Stern's tube transmitter and receiver

It is, of course, understood that the two pole switch must be thrown to the "arc" position when it is desired to transmit, so that the bulb will oscillate. It will repay the effort to add these appliances.

Government Control

GOVERNMENT control of radio communication, placed in the hands of the navy department, appears to be a dismal failure when compared to the class of service rendered by private concerns prior to the war, when radio communication was a "free for all" service.

The causes for this are numerous. In the first place, naval work is, in the main, carried on by inexperiened, incompetent men, who have had little or no practical experiene in the handling of commercial radio traffic. Another reason is that the stations on shore which formerly handled only commercial business, and were kept working to their very limit with that, now have to handle naval work and matters of tactics as well as commercial traffic. I have seen traffic suspended for hours at a time—have heard as many as seven different ships after the operator at Miami station at one time, trying for hours to raise him. This has happened not once, but numerous times. Where was he? When this station was under the control of the Marconi Company the matter would have to be explained in a very satisfactory manner. Now it is different; it seems to get by without any trouble.

At the port of New York things are very confusing. There are three different stations using the same call letters—NAH—which is the cause of considerable difficulty to some ships. To illustrate: I have heard messages sent in to NAH, one station coming back with an O. K., while one of the other NAH's wanted a part of the message repeated. Sometimes one NAH will say "K" and another one will say QRT; if you answer one you get logged for unnecessary interference when told to QRT; and if you don't answer, the other station logs you for inattention. So what are you going to do?

The majority—I don't say all, but a surprisingly large number—of the naval radio men are very poor operators. They, by the way, are the only naval men aboard the merchant marine vessels, all the rest of the crew being civilians with the exception of half a dozen naval cadets who are learning navigation with a view of entering Pelham Bay. It is these men who cause unceasing tie-ups in traffic. One ship in particular, a well known passenger vessel, has an operator (or operators) on board of her whose maximum speed of reception seems to be between twelve and fifteen words a minute, providing the air

is clear of static and interference. If there is any interference at all, this speed materially drops and the ship station is hopelessly lost. I have exchanged traffic with this vessel when signals were readable with the motor generator running, and if messages were sent to him at a speed greater than fifteen words a minute he could not copy them.

I have interviewed a number of naval operators on different merchant ships at various ports in the United States and in other countries, and they all seem to be of the same general opinion: That naval monopoly of radio is a dismal failure, due, for the most part, to the class of operators employed. They will tell some such story as this, when asked their opinion: "Before I joined the outfit I was so and so, making twice as much in a week as I can make here in a month. I joined up for the duration of the war, and now that the war is over, I am anxious to get back to my old job. They are discharging men from practically every other branch of naval service, and I think it is unfair to you and to us to keep us here where a civilian who makes this work his life's vocation would do much better. We take no interest in our work, we do it because it has to be done, we are only in hopes that such a kick will go in to the navy department regarding our service that we will be let go."

One of the naval operators on a passenger ship with whom I spoke said: "Do you suppose we keep a steady watch here like you fellows do? We do not. We work just about as we please, and as for messages, we don't give a hang whether they get off or not."

Now if that attitude was ever displayed by an operator in civilian service he would last with a private concern only long enough to be relieved by a man who *did* care. It is obvious that a man who is compelled to do a certain work against his liking will not do as good nor as efficient work as one who does that kind of work because he likes it and takes an interest in it. A man in a private concern who could not prove himself efficient would not last very long. I am certain that the navy's reputation for high efficiency was ***not*** established by the radio branch of the service.

The instruments that the naval operators have to work with are examples of the latest advancement in the art of radio communication and in themselves are works of art. But —put a man at those same instruments who takes pleasure and an interest in the successful working of them and he will get a great deal more efficient work from them than a man who "doesn't care."

One thing that the navy department is doing which is very unjust and entirely uncalled for, is the replacing of civilian radio operators on merchant marine vessels by naval operators. For instance, during the war, on some of the ships crossing the Atlantic, we were allowed to remain on. These in almost every case were *unarmed* ships. As soon as the ships were *armed* we were put off and navy men put aboard. Now on English, French and Italian ships, even transports, civilian operators were employed throughout the war. On American ships, the civilian radio men were ruthlessly "dumped." Even under the present conditions of peace, civilians are being replaced by naval radio men!

The loyalty of civilian operators during the war was unquestioned. Yet on American ships they were replaced on their jobs by an inferior grade of inexperienced and incompetent naval operators. We were immediately deprived of our means of livelihood. many of us, due to various reasons, could not join the naval service, even if we had been so inclined. This was very unfair treatment on the part of the navy department. It would not have looked so bad if the entire ship's crews had been naval men; but when every man from the master down to the coal passers were civilians, to have civilian radio men removed and naval men put on was rather a hard pill for us to swallow. On no other Allied ships was this done.

Navy radio men are as much out of place on a civilian merchant marine vessel as civilian operators would be if placed on a naval man of war. We are in hopes that in the near future naval operators will be removed from the merchant marine service and the ships turned over to civilian operators again as in the days before the war. Then, and *only* then, will satisfactory service be given, because the service will once more be conducted by competent men.

AN OLD TIMER.

Queries Answered

Answers will be given in this department to questions of subscribers, covering the full range of wireless subjects, but only those which relate to the technical phases of the art and which are of general interest to readers will be published here. The subscriber's name and address must be given in all letters and only one side of the paper written on; where diagrams are necessary they must be on a separate sheet and drawn with India ink. Not more than five questions of one reader can be answered in the same issue. To receive attention these rules must be rigidly observed.

Positively no Questions Answered by Mail.

L. D., Kinsale, Va.:

The receiving apparatus you describe ought to respond to transmitting stations, during the favorable months of the year, over distances up to 2000 miles.

Any receiving tuner employed in connection with crystal detectors may be used with a vacuum tube, but the tube generally gives the best signals when connected in a secondary circuit in which inductance predominates. The shunt secondary capacity should not exceed .0005 mfd.

Any receiving tuner may be fitted with regenerative coupling. It is only necessary to put a few turns of wire in the plate circuit and inductively couple that circuit to some part of the grid or antenna circuit of the receiving set. The Wireless Age, from month to month, has published numerous diagrams applicable to such work.

The use of a variometer in the antenna circuit is not strictly essential but it aids one in obtaining fine tuning in apparatus when the inductance is varied by taps instead of by a "tens" and a "units" switch, such as is employed with modern receiving tuners.

Regarding your last query: You will find that the Marconi V. T. oscillation detector connected up in the receiving circuit shown in a leaflet which accompanies each order will double or triple your present receiving range.

* * *

A. R., Scottville, Mich.:

When a storage battery is on "floating" charge, a small charging current is passed through the cells continuously. In ship radio sets, two incandescent lamps passing 1/2 ampere each are connected in series with each bank of cells. This slow charge makes up for local losses and keeps the battery at its maximum E.M.F. at all times.

The American Morse test of 30 words per minute given in the Government examination for an Extra First Grade License Certificate is conducted by sounder, not by buzzer.

Replying to your last query: We do not believe that daily newspapers are in the habit of divulging the contents of radiograms unless they receive permission for so doing. The press matter sent out by Arlington, nightly, may be used freely by any one, but the ordinary radiograms cannot be produced without permission from the sender.

* * *

J. D. M., Springfield, Mass.:

The wave length of the radiated wave in wireless telegraphy is the actual physical distance between two successive points in the wave motion where the stress is in the same direction and of the same amplitude.

The length of the radiated wave bears the following relation to the inductance and capacity of the antenna circuit. Letting the Greek letter Lambda λ = wave length, L_1 = the inductance of the loading coil at the base of the antenna and $\frac{L_o}{3}$ = inductance of the antenna for alternating current and C_o its capacity, the following formula obtains:

$$\lambda = 59.6 \sqrt{(L_1 + \frac{L_o}{3})\, C_o}$$

Here L_o is the inductance of the antenna for uniform curve distribution and C_o its capacity for uniform current distribution. $\frac{L_o}{3}$ and C_o may be taken as the inductance and capacity of the antenna for radio frequencies

The wave length of a simple vertical wire grounded at one end is four times its natural length. Thus an antenna of 100 meters in length will radiate a wave of 400 meters.

* * *

R. D. W., Plainfield, N. J.:

We do not know the nature of the crystals sold under the name of Lenzite and Radiocite.

Regarding your experiments with cerusite: Genuine cerusite will not act as an oscillation detector in radio. What formerly was assumed to be cerusite was nothing more than a grade of galena of a different crystal formation than that ordinarily used by experimenters.

You will have great difficulty in obtaining a permanent adjustment for galena. Have you tried an opposing contact of graphite, such as the lead from a lead pencil? It is said by some experimenters that this design tends to give permanency of adjustment.

* * *

W. G., New York City:

Note the reply to R. D. W. above. The cerusite crystals you sent to us are not suitable for detection of radio signals.

The radiophone transmitter set shown in the March issue will transmit 10 or 15 miles, the actual range depending upon the type of receiving apparatus employed. We are unable to state why your audiotron detector does not function properly. Perhaps there are weak cells in the B battery, or it may be that the secondary winding of your receiving tuner has insufficient inductance to impress the high E. M. F. on the grid circuit, requisite to make the vacuum tube function properly.

* * *

W. L. D., New York City:

The methods of connecting up the vacuum tube as a transmitter or receiver are numerous. We urge that you try all of the circuits heretofore published and decide for yourself which is the most applicable to your particular work. The text book "Vacuum Tubes in Wireless Communication" has descriptions of all the circuits that have been proposed or used.

The diagram of figure 48 on page 80 of that text book should satisfy your requirements, although if you employ a modern tube which is highly exhausted, you should connect a two megohm grid leak from the grid to the filament of each valve. The first tube in that diagram is connected for radio frequency regenerative amplification and one stage audio frequency amplification is provided for the plate circuit. In the newly revised edition of "Vacuum Tubes" you will find on page 180 in the diagram figure 133, the fundamental circuits of a vacuum tube radio telephone set that is applicable to most any type of bulb suitable for the generation of radio frequencies. The coil L-6 in that diagram has inductance from 10 to 13 millihenries, L-5 may have an inductance of 1/2 millihenry or so. The series condenser in the plate circuit may have a capacity of 1/10 mfd. The telephone transformer P-2, S-2 may be of the ordinary iron-core type. The filaments of the oscillator and modulator bulbs may be connected to the same source.

Wireless telephone communication may be carried on over distances of 100 miles with antenna current of 2 amperes provided at least a three-stage vacuum tube amplifier is used at the receiving station.

Figure 125 of "Vacuum Tubes in Wireless Communication" shows the diagram of a resistance coupled three-tube amplifier which is suitable for cascade radio or audio frequency amplification. The diagram shows a circuit for regenerative radio amplification and beat reception, but perhaps better results will be obtained by using a single bulb for generating radio frequency currents and placing it in inductive relation to some part of the antenna circuit.

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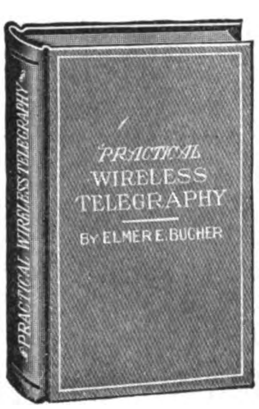

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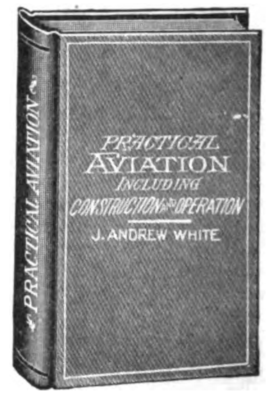

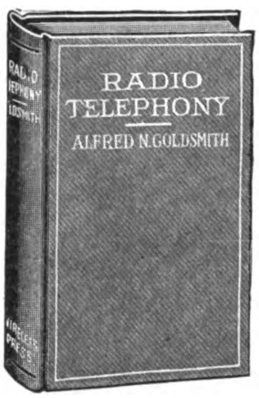

Radio Telephony

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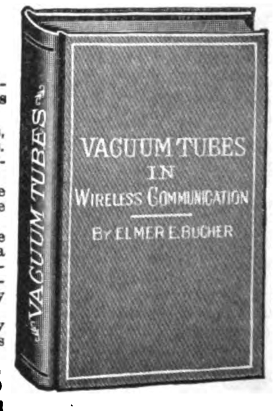

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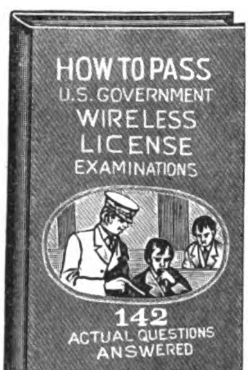

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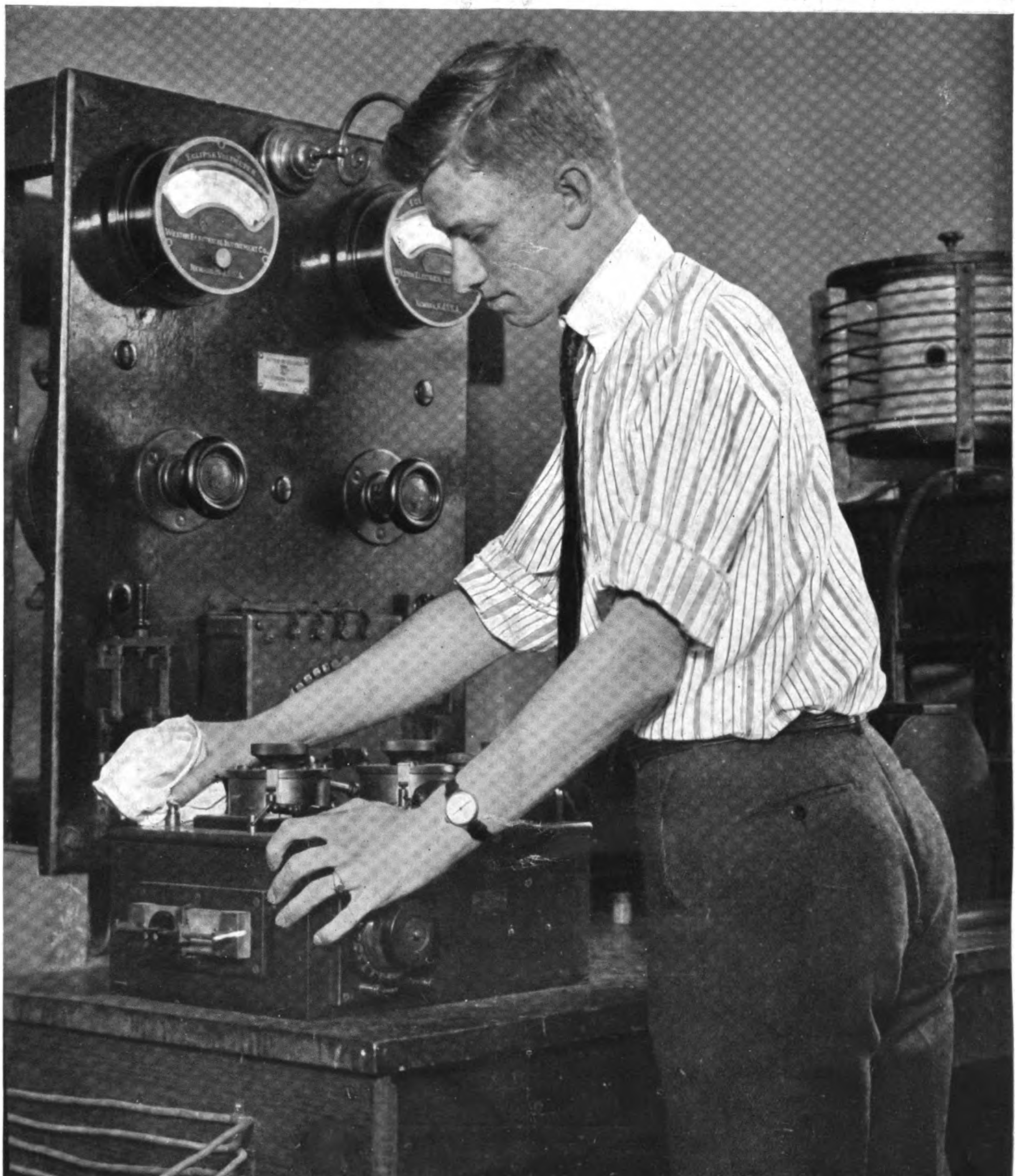
The WIRELESS AGE

Volume 6

Number 11



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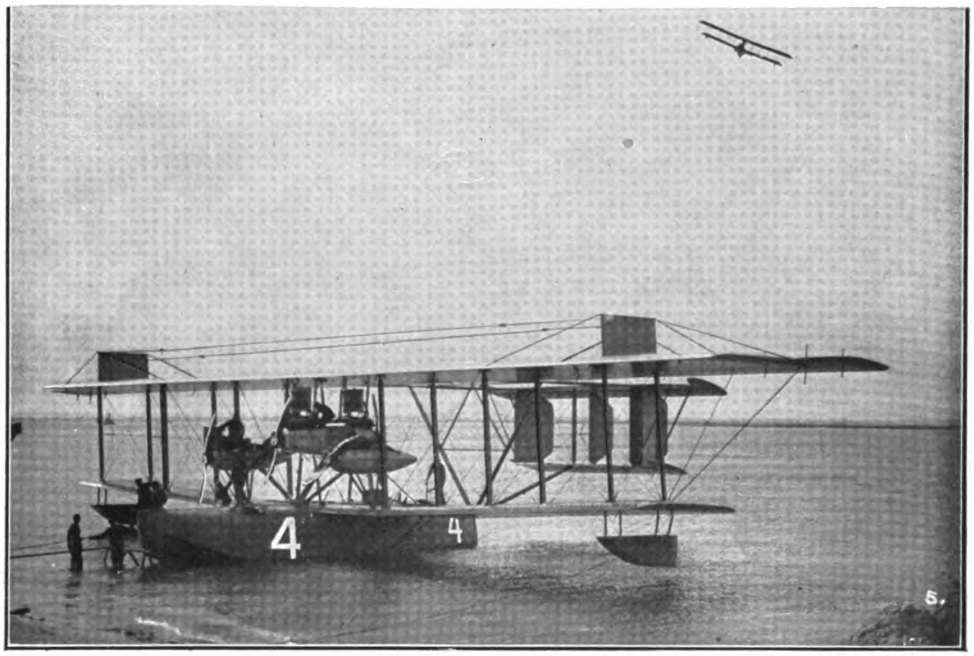

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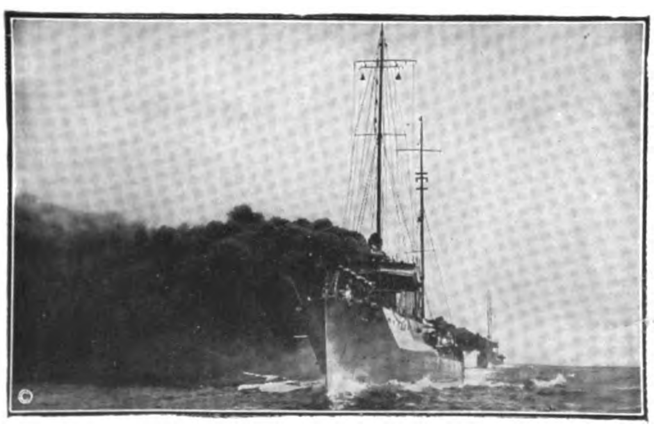

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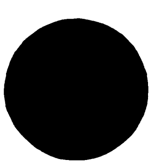

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The Wireless Age

Edited by J. ANDREW WHITE

Vol. 6 — No. 11

Contents for August, 1919

Index of Equipment

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Vol. 6. No. 11. August, 1919

THE WIRELESS AGE

WORLD WIDE WIRELESS

Allies Undamped Wave Sets Fooled German Airmen

AMERICA and the Allies outwitted German airmen by means of the wireless telegraph. A captured German army order made public by the army air service shows the importance which the German military leaders attached to wireless, also that they were anxious to duplicate it. The order reads:

"The enemy has found it possible to use wireless installations for undamped waves in his aeroplanes. So far few fittings of this type of apparatus have been captured by us, and in order to enable us to make use of this as soon as possible and also so as to save millions which would have to be spent in experiments, it is every one's duty to see that all wireless telegraph fittings from captured airplanes are saved as completely as possible. Even the smallest pieces will be collected, as a tyro cannot recognize the value and importance of small parts to the expert.

"In view of the importance of these fittings for our own wireless telegraphy, sums paid for this salvage will be high."

The order was dated June 6 last year. It indicates that the Allies were far ahead of the German radio experts and that Germany was prepared to spend millions to bring her equipment up to a point where it would be equal to that of the Allies.

This is one of the reasons why the American aviators when forced to land on German territory burned up all their machines and equipment. In fact, the order shows that Germany did not know the United States had developed the practical wireless telegraph and telephone for airplanes until long after it had been in use.

Airplane radio telegraph sets of the continuous wave type were used by the Allies as early as the spring of 1917.

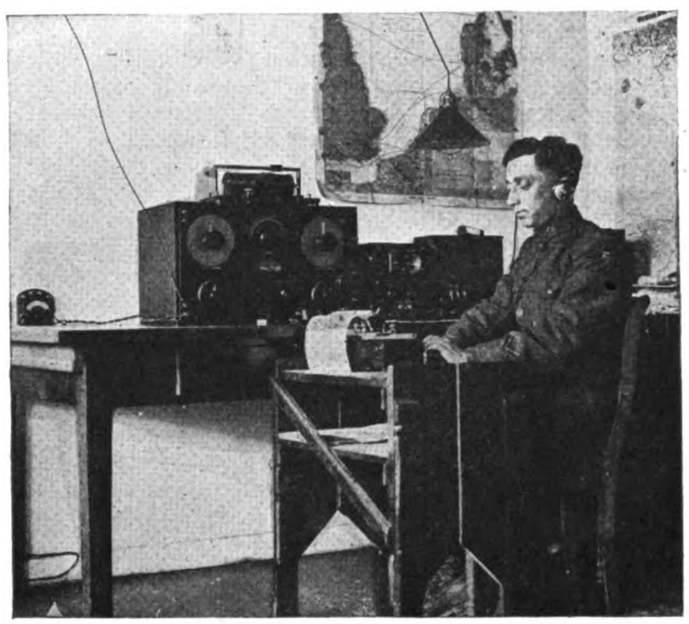
British South Pole Expedition to Use Wireless

A SIX years' polar expedition by British explorers and scientists to the South Pole, in which an aeroplane will be utilized in accomplishing the final stages of the trip, is to be started in June, 1920. The proposed expedition, under the leadership of John L. Cope, F. R. G. S., who accompanied the Shackleton expedition as surgeon and biologist, will be known as the British Imperial Antarctic Expedition. Its objects are:

1. To ascertain the position and extent of mineralogical and other deposits of economic value.
2. To obtain further evidence of the distribution and migration of whales of economic value.
3. Generally to extend the knowledge of Antarctica, especially with a view to obtaining further scientific data of economic importance.
4. To investigate the meteorological and magnetic conditions of the Ross Sea area and at Cape Ann in connection with their influence on similar conditions in Australasia and South Africa respectively.

While the expedition is to be gone six years, it will not be cut off from contact with the civilized world, because it will take along a fairly powerful wireless set.

The famous exploration ship Terra Nova will take the expedition to the southernmost parts reachable.



Copying press on high wave lengths at an A. E. F. station at Neuweld, across the Rhine

Magnifying Sound Four or Five Million Times

A MAN'S voice can be made as loud as the cannon's roar; it can be heard two or twenty miles. The ticking of a watch can be amplified until it sounds like breakers on an ocean cliff.

In the stadium at Golden-Gate park the ticking of a watch was made audible all over the grandstand while an athletic meet was in progress. Captain Robert W. A. Brewer, an experimenter, moved off 2,000 feet and spoke quietly to his dog, and the dog couldn't be held. A wireless station recently received a telephoned message from Europe, and through its amplifier startled duck hunters in the marshes eight miles away.

Wireless Compass Station Established at San Diego, Cal.

OFFICIAL announcement is made that the Navy Department will establish a radio compass station at San Diego, Cal. This will permit inbound naval or merchant shipping to adjust compasses through information flashed from the Point Loma Station.

The Future of Wireless and Aviation

SPEAKING at a luncheon of the Aldwych Club recently, Godfrey Isaacs, managing director of the British Marconi Company, told of a new plan his company had for enabling aviators to tell where they were. After mentioning the wireless direction finder, Mr. Isaacs said:

"A further development had given them a new transmitter, which would project into the air a wide divergent beam, something like a searchlight without the light, which would extend over any area required, or, if it was desired, a concentrated beam over some small place, and those beams would convey to the men in the sky automatically the name of the place they were passing over.

"Assuming that a man was passing over the town of Guildford; from the moment he traversed the region over which this beam was playing he would receive the signal, 'This is Guildford,' and would continue to receive that signal as long as he was over Guildford and no longer. In the same way, if he was passing over Windsor Forest he would be told, 'This is Windsor Forest,' and when he came to his aerodrome a beam would tell him 'This is Hendon Aerodrome!' In that way he thought that one of the greatest dangers to pilots in fog and in darkness was disposed of.

"It required very little imagination to see, a little while hence, some thousands or tens of thousands of names being projected into the skies, so that in whatever part of the world an aeroplane might travel, it would be told continuously and automatically where it was. It would be as easy to learn in the skies where they were as in a railway train when they looked out of the window to see the name of a station.

"Similarly these beams could be equipped to lightships or to buoys in fixed and defined positions, so that even when passing over the sea one would know exactly where one was. When that position of things had developed pilots would no longer lose themselves, wherever they might be."

Enlarging on the commercial possibilities of wireless, Mr. Isaacs said:

"A cable required a very big capital outlay, its cost of maintenance was very considerable, and its capacity for traffic was limited. The cost of a wireless telegraph station was moderate, the cost of maintenance was small, and the capacity for traffic was practically unlimited.

"Wireless to-day could do 150 words a minute simplex and 300 words a minute duplex. It would require but a very small mechanical improvement to double and quadruple that number of words transmitted by wireless." He was quite satisfied that so soon as wireless traffic needed the greater speed of transmission mechanical improvements would be introduced, and they would get something in the neighborhood of 600 words a minute.

Wireless Telegraphy on Board British Ships

LORD SOMERLEYTON'S bill to make further provision with respect to wireless telegraphy on British ships has been issued. It provides that every sea-going British ship registered in the United Kingdom, being a passenger steamer or a ship of 1,600 tons gross tonnage or upwards, shall be provided with a wireless telegraph installation, and shall maintain a wireless telegraph service which shall be at least sufficient to comply with the rules made for the purpose under this Act, and shall be provided with one or more certified operators and watchers.

The Board of Trade may exempt any ships if they are of opinion that, having regard to the nature of the voyages or other circumstances the provision of a wireless apparatus is unnecessary or unreasonable. The Board of Trade, in consultation with the Postmaster-General, shall make rules prescribing the nature of the wireless telegraph installation to be provided, of the services to be maintained, and the number of operators and watchers to be carried. If this section is not complied with the master or owner of the ship shall be liable in respect of each offense to a fine not exceeding £500, and any such offense may be prosecuted summarily, but if the offense is prosecuted summarily the fine shall not exceed £100.

"Passenger steamer" shall mean a steamer which carries more than twelve passengers.

New Wireless Station to Be Built in Cincinnati

CAPTAIN J. P. GRAY, of Washington, a member of the U. S. Coast Guard service, recently visited Cincinnati to make a preliminary survey of possible locations for a Government wireless station there. It will be used for the army, the Weather bureau and other departments.

Dutch East Indies Get Wireless Station

ACCORDING to the Dutch East Indian Commercial Review, a wireless station is now being erected in the Dutch East Indies to transmit messages from Holland direct to the East Indies without relay. The Review says: "The receiving station for the wireless communication between Holland and the Dutch Indies will be erected at Boxmeer (North Brabant), the sending station near Apeldoorn (Gelderland). The station near Apeldoorn gets six masts, 210 meters high. The distance between Holland and its D. E. I. colonies is 11,000 kilometers and this distance will be reached without substations."

Wireless Aids President Wilson in Governmental Work

INDICATING that the public business—or at least some of the public business— was not to suffer while he was away, President Wilson signed appropriation bills aboard the George Washington and a wireless was sent the White House that they had become law.

Such action has been approved by the Attorney-General, and was taken by the President when the first Urgent Deficiency Bill was passed.

The ship is American territory. The White House has become a floating one.

Wireless Telephones Aboard Merchant Ships

EXPERIMENTS in wireless telephony from a merchant vessel, conducted recently aboard the steamship Parismina as she was on her way back from Colon to New Orleans, met with great success.

Should the experiments prove wholly successful, the wireless telephone may supplement the wireless telegraph, now a part of the equipment of practically every ship that goes to sea. Officers in charge of the tests have not yet made a report but it is understood that the experiment bore out the fondest hopes of those in charge.

The messages, from reports, were picked up perfectly at shore stations and the voice was heard as distinctly as is the every-day telephone conversation on shore.

Replies as received from radio operators at sea showed that the voice was distinctly heard, even at long distances.

In the Wireless Room With Marconi

THE Italian who has most appealed to the American imagination, however, is Guglielmo Marconi, says Isaac Marcosson, in the Saturday Evening Post, "I did not meet him until after the outbreak of the war, but I saw him many times and in varied circumstances—at sea, in London, and in Rome. Marconi is slight, nervous, emotional. He speaks English fluently and his wife was English. He is one of the most accessible of men and from long experience knows the interviewing ropes.

"In war as in peace his greatest invention has an immense value. Without wireless some of the most vital phases of the great struggle would have been impossible. The historic S O S call of distress, flashed across the troubled seas, is the world's supreme life saver.

"Marconi made possible one of the unique experiences I had in the war," the writer notes. "In July, 1917, we were fellow passengers on the old American liner St. Paul, then bound from New York to Liverpool. Then—as throughout the war—the wireless room on a steamer was a sacred and inaccessible domain. Only the ship's officers were allowed to enter it.

"One night when we were in the heart of the danger zone—and the submarines were then at their worst—Marconi came to my stateroom and said: 'Would you like to hear how some of the German lies sound in the air.'

"He referred to the German Admiralty wireless reports that were sent out nightly with the news of Teutonic successes.

"'Yes,' I responded.

"'All right,' he replied; 'let's go up into the wireless room.'

"We climbed up a slippery ladder and found ourselves in a tiny room where the operator sat at his instruments with the receivers at his ears.

"Instinctively Marconi took the receiver from the operator's head and put it on his own. The master of wireless was on the job.

"Then handing the receiver to me he said:

"'You can now hear the whole world at war talking.'"

"I listened. To me it was simply a jumble of dots and dashes. Yet that melange of sound was Germany, England, France, America and Italy throwing the fateful news of the day out into the unplumbed spaces."

Marconi and Gabriele d'Annunzio, the Italian poet-soldier, are close friends, Mr. Marcosson observes. Each has a sense of humor strong even in misfortune. Marconi lost an eye in an automobile accident in France and D'Annunzio lost one in aerial combat.

"During the trip to which I have just referred Marconi showed me a telegram which he had recently received from the poet, which read, as I recall it:

"'We are now two souls with but a single pair of eyes. D'Annunzio.'"

Wireless Whims

IT will be a great day when wireless telephony is so perfected that a man can have a receiver in his hat and be managed by his wife all the time.

"We were much jammed by strong wireless signals not intended for us," Captain Alcock said of the great ocean flight. Big field up there. Great newspapers will have a fleet of planes on the roof where we now have pigeons, and alert young aviator-reporters on dull nights will get an order something like this: "Jones, take the Blurb 4-11-44, tethered at the northeast corner of the building, go up a couple of miles and see if you can pick up a bit of live news."

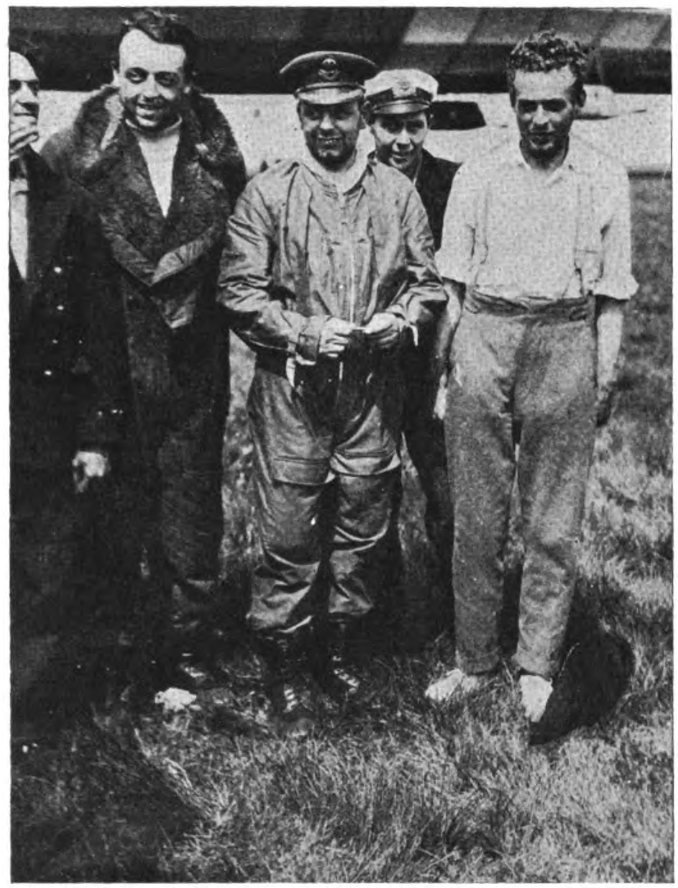
A miscellaneous collection of wireless apparatus lay on a counter in an electrical store which is the rendezvous of New York wireless amateurs, and a salesman explained that it was pre-war apparatus which was being sold out at special prices.

An amateur stood gazing at a loose coupler which would have been the pride of any amateur a few years ago. The salesman, seeing the interested look of the amateur, approached. "Would you like to buy that loose coupler cheap?" he said. With a sudden look of scorn the seemingly interested amateur replied:

"Naw! I outgrew that stuff long ago. I was just looking at it as a matter of historic interest." And that is precisely the way things go with these ambitious young Americans who dabble in wireless.

Brooklyn Navy Yard Uses Radio Compass

THE radio compass device has reached such a state of development that navigators at the Brooklyn Navy Yard are enabled to give bearings to ships lost in fog off the Atlantic coast.



Left to right—Lieutenant Durrant, wireless operator; Major G. H. Scott, navigator; Major Cook (coatless), part of the crew of the R 34, the dirigible that crossed the Atlantic

The vessels wire the Naval Communications Office when they want assistance. Then, with the aid of several stations, the office fixes the ships' locations and they can proceed without waiting for clear weather.

Increased Wireless Service Across the Pacific

THE present capacity of naval radio transmission across the Pacific ocean will be increased to six times the present capacity by the installation of several automatic high speed sending and receiving apparatus on the San Francisco-Pearl Harbor lines and the opening of a second trans-Pacific radio circuit. Plans for the improved service have already been made in Japan according to the report.

The Speed of Electricity

By A. E. Kennelly, Dr. Sc., A. M.

Vice-President National Wireless Association
Professor of Electrical Engineering at Harvard University;
President of the Institute of Radio Engineers

THE speed of electricity is generally known to be very great, but when a specific question is asked as to what is the speed of electrical transmission of signals over wires, as in telephony, or over a wire and the ground, as in telegraphy, or over the ground alone, as in radio communication, it is very difficult to find a precise answer. Nevertheless, the answer to such a question is of great practical importance in certain engineering undertakings, such as the establishment of the longitude of a station by electric signals from another station whose longitude is already established. Moreover, the subject is of great intellectual interest. Its study has occupied the lives of many scientific investigators. The boundaries of this field of inquiry are far reaching and numerous. They touch upon relativity, the question of infinity in space and time, and the very framework of the known universe. It is only proposed to discuss here a very small part of this vast subject; namely, the speed of electricity insofar as it relates to electric signals, and particularly to radio signals.

Very Brief History

Prior to Maxwell's time, the speed of electricity over wires was considered as distinct from the speed of light, both experimentally and philosophically. It was realized that the speed of electricity was numerically of the same order as that of light; but the phenomena were regarded as independent. Wheatstone, in 1834, made some laboratory measurements, with a revolving mirror, on the delay of a spark discharge across a gap in the middle of a long wire loop, as compared with a spark across the sending terminals, from which the apparent speed of the current over the wire was 463,500 kilometers per second; but very different results were obtained in various repetitions of the experiment: so that this method of making the measurement was for a long time discredited.

Maxwell's theory, in 1867, of light as an electromagnetic phenomenon, changed the aspect of the question. Assuming that the theory was reliable, it became unnecessary to measure the speed of electrical currents, because the speed of light had already been measured with a fair degree of precision, and bid fair to be measured with yet greater precision in the future.

Maxwell's theory, when first enunciated, depended in a large measure for confirmation upon the corollary that the speed v of transmitting electromagnetic disturbances perpendicular to their wave front is

$$v=\frac{1}{\sqrt{k\mu}} \qquad \frac{\text{cm.}}{\text{sec.}}$$

where k is the dielectric permittivity of the medium, or its "specific inductive capacity," and μ its magnetic permeability. This latter value is unity in vacuo and very nearly unity in all nonmagnetic substances. Consequently, if the permittivity of the medium were quadrupled, the speed should be halved. But the ratio of the velocity of light in vacuo to that in a nonmagnetic solid transparent medium, such as glass, is optically defined as its "index of refraction" ν so that the index of refraction of a transparent dielectric should be numerically equal to the square root of its permittivity k. In a fair number of instances, the agreement between measured values of ν and $\sqrt{k}$ was found to be satisfactory, especially when k was measured at relatively high frequencies.

Maxwell's theory also received support from the fact that it required the ratio of the units in the electrostatic and magnetic C. G. S. systems to be simple functions of the velocity v of electromagnetic wave propagation, or of light. Thus, taking the units of capacitance, if an air condenser had its capacitance measured in abfarads and also in statfarads, the number of statfarads should be v^2 times the number of abfarads. This ratio checked satisfactorily, and is now regarded as perhaps the most

Sir Charles Wheatstone in 1834 added to the knowledge of electrical measurements by his research work and laboratory experiments

precise method of determining inferentially the velocity of light.

Hertz's experimental researches with electromagnetic waves have confirmed Maxwell's theory, and have established the belief that light is an electromagnetic wave disturbance, optically differing only from electromagnetic waves of the laboratory, in wave length or accompanying frequency.*

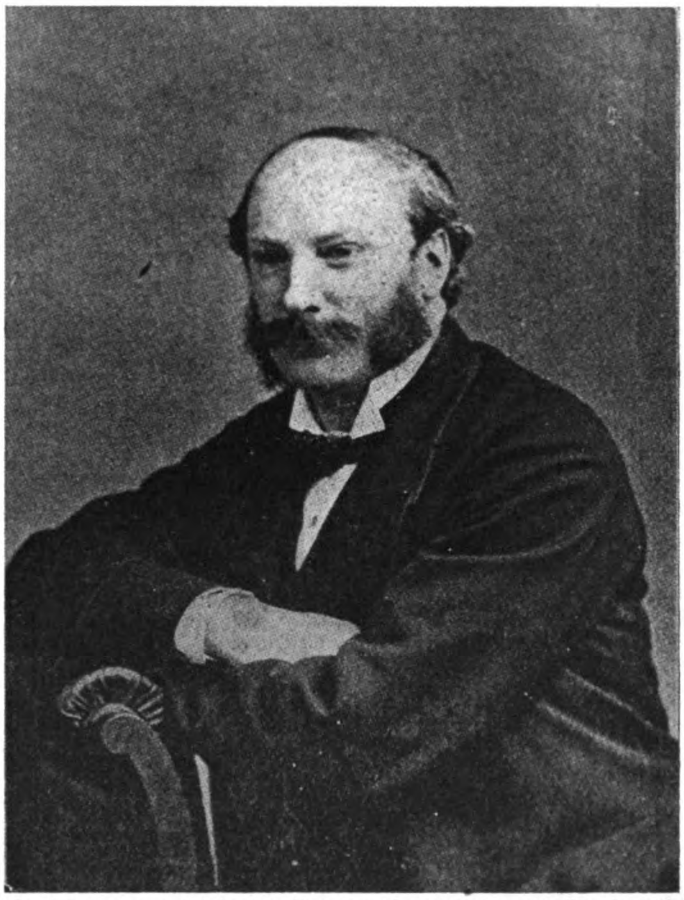
The velocity of light has been measured by optical methods† and the best mean result is generally taken as $v=299{,}860$ km. per second, or 2.9986×10^{10} cm. per sec. The question as to whether this velocity varies with the wave length, has been hitherto answered in the negative, by various astronomical observations, so far as the wave

*The condition of polarisation of light is here left out of consideration. Radio waves are generally agreed to be not merely long-wave light; but also polarised light.

†Encyclopaedia Brittanica "Light," 11th Edition; also Bulletin of the Bureau of Standards, Vol. 3, No. 4, page 603, 1907.

lengths in or near the visible spectrum are concerned, and also so far as concerns the longer electromagnetic waves of the electric laboratory, by the fact that the best value of v obtained from the measurements of the ratios between electrostatic and electromagnetic units, at very low frequencies, are in agreement with the value of v obtained in optical measurements at luminous frequencies, estimated as lying say between 4×10^{14} and 10^{15} cycles per second.

Summing up the accepted beliefs concerning the speed of electromagnetic disturbances in straight lines, we may say that, for practical purposes, the velocity v is very nearly 300,000 km. per second, in vacuo or free space, and is independent of the frequency or wave length. In air, at standard temperature and pressure, the value of k is taken as 1.00055, as against unity for vacuum; so that the speed of transmission in air is taken as less than in free space in the ratio of 1.00028, or only about 3 parts per myriad. The difference between the speed of propagation in air or in vacuo is therefore relatively very small from an engineering point of view. In rarified air, the retardation of velocity is to be considered as still less, or the velocity is still nearer to v in vacuo.



Lord Rayleigh, noted for his discovery of argon, also contributed to the knowledge of electrical measurements by his discovery of the laws of "group speed" of waves

Velocity of Transmission Over Wires

Granting that electromagnetic disturbances move in the free space with the uniform speed v, as above defined, the next question is what is the speed at which they move over conductors?

The answer is that the speed of disturbances over conductors is always less than that in free space. If the conductors are, say, two parallel copper wires, insulated in and separated by a solid nonmagnetic dielectric of permittivity k, as measured as the proper frequency, then the speed of disturbance in the dielectric would be expected to be $\frac{v}{\sqrt{k}}$ But even if the dielectric medium surrounding the two wires is air, for which k is substantially unity, and their distance apart remains uniform, the speed of transmitting electromagnetic disturbances in the air would be v; but the speed of conducting the disturbance along the wires would be less than v; owing to attenuation or absorption of energy into the conductors, or into the insulators supporting the conductors; or finally into the air itself. In other words, the speed of transmitting electric signals over the wires would be less than the speed of transmitting electromagnetic-signal disturbances through the air alone, owing to loss of energy in the wires, or in the insulation. It is believed that if there were no loss of energy, the speed of transmitting the signals over the wires would be v, the same as the speed in a straight line through the air. Suppose, for example, that an electrical dot impulse, of rectangular wave form, is started off along a pair of parallel aerial telegraph line wires from the sending end. The impulse travels through the air guided by the wires. Owing to resistances losses of various kinds, the impulse attenuates, and also changes its wave shape as it proceeds, so that it arrives at the distant end, no longer as a rectangular wave impulse, but as a rounded wave rising gradually from zero to a maximum. The instant when the wave is considered to arrive at the receiving station would depend upon the sensitiveness of the receiving device. A highly sensitive receiver would be likely to register an earlier arrival than a receiver which only responded to the crest value of the incoming wave. The speed of transmission thus not only becomes lower than the speed of advance through the air; but it also becomes difficult to assign. The higher the linear resistance of the wires, the greater the capacitance of the insulators supporting the wires, and the greater the effective radiation resistance of the system, by which the energy in the advancing wave becomes dissipated, either in heating the conductor, or magnetising it internally, or charging the insulators, or radiating off sideways, the lower the speed of signal transmission would appear to be, as judged by the interval of time between an instrument at the sending station recording the starting of the wave, and a similar instrument at the receiving station recording its arrival. If, however, the wires could be made perfectly conductive and the insulators made completely nonabsorptive—so that there were no resistances and no energy losses—then we should expect to measure a speed of transmission of signals over wires equal to v the speed of advance through air. In practice, these ideal conditions are unattainable, and the apparent speed of signal transmission over conductors is always less, and sometimes much less than the speed v of waves in the dielectric, after allowing for its permittivity k. Consequently, the speed of signal transmission becomes an indefinite quantity, always less than v, but having its value dependent upon various considerations affecting the conductors, including also conditions in the receiving instrument.

Group Velocity of Waves Over Wires

If, instead of sending separate impulses or discrete signals over a pair of parallel wires, we send a train of simple alternating-current waves at a steady frequency, then the meaning of the phrase "speed of electric transmission over wires" becomes definite, but still slightly different from that of v the "speed of electric transmission through air." As was pointed out by Rayleigh, what is observed with alternating-current waves is the "group speed" of the waves, which is not identical with, and is less than, the speed of the wave disturbance. The difference is again due to the attenuation or decay of the waves, from losses occurring during transmission. The successively arriving waves are weakened by these losses, but they still remain sinusoidal in shape. The distortions

in wave shape of simple alternating-current waves advancing over uniform aerial conductors, due to attenuation, are such as still leave the arriving waves of simple alternating-current form. The wave length of the train is apparently diminished, and the velocity of arrival is apparently diminished, but the frequency or number of waves arriving per second remains the same as the frequency of the waves delivered by the alternator at the sending end. The lower the resistances and losses of energy in transmission, the more nearly the group speed, or apparent velocity of motion, approaches the speed v of the wave disturbance for unguided waves in air. Moreover, the higher the frequency, the less the deviation of group speed from wave speed, other conditions remaining the same.

A crude analogy to the phenomenon of group speed retardation is presented in the case of waves of infantry advancing over a plain, and subjected to a progressive attenuation or destruction by gunfire. Each successive wave may, at regular intervals, start off and proceed throughout the journey with a uniform speed of, say, 3 km. per hour. If the distance to be traversed is just 3 km., the waves without any attenuation would take just one hour to make the journey. But with attenuation, the leading wave may be completely destroyed before it reaches its destination. If the speed of transmission is measured by the time that elapses before a wave registers its arrival, this group speed may work out very appreciably less than the actual 3 km. per hour at which the advance of each unit is being made. The case of electric wave transmission under consideration does not contemplate the extinction of entire waves, and the attenuation is a more gradual and regular process; but in both cases, the cause of the retardation is the same.

In laboratory measurements made on the speed of alternating-current waves over parallel wires in air, the group speed has been found to agree very closely with that of v, after allowance has been made for attenuation. A number of such measurements have been published.*

We may, therefore, sum up the matter of alternating-current wave transmission over uniform wires by saying that the observed group speed under favorable conditions can be brought very nearly up to v, and that in other cases where the conditions yet remain simple, the reduction in the apparent or group speed can be explained.

Speed of Transmission of Radio Waves

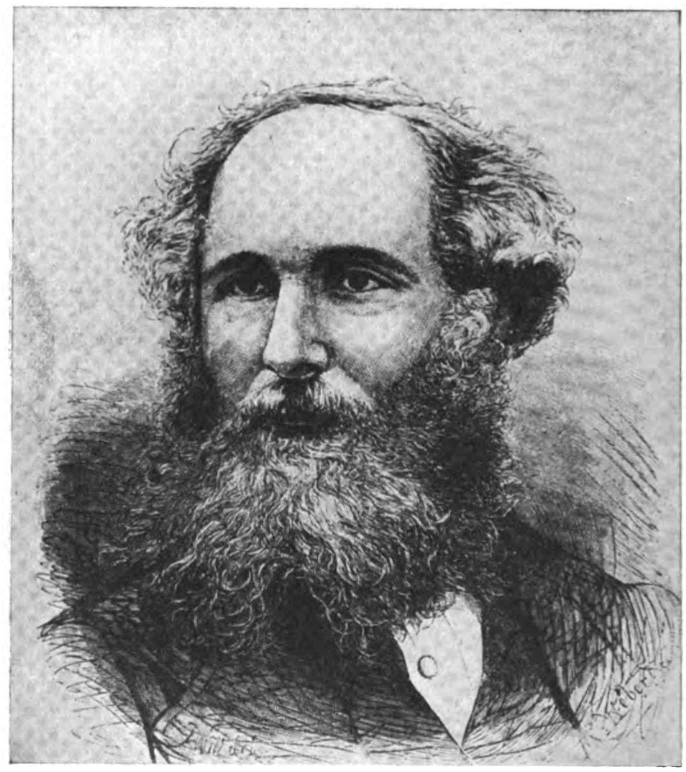
A long train of radio waves advancing hemispherically over the conducting surface of the sea may be regarded as a case of alternating-current transmission over a large conducting surface. If the sea were a perfect electric conductor, and if the earth were flat, and the atmosphere a perfect insulator of $k=1$ throughout, we should expect that the observed group speed of transmission would be identical with v the speed of wave transmission in space. The question is, what will be the speed over a spheroidal earth with actually imperfect conductivity in the land and sea, and imperfect insulation in the atmosphere? The curvature of the earth will have a certain retarding influence, owing to the interference of perpetually bending alternating currents, or what corresponds to diffraction† in optics. The imperfect conductivity of the surface and the imperfect insulation of the atmosphere involve losses of energy which probably tend to reduce the group velocity. Moreover, these factors are not independent, but mutually influence one another. Thus, the conductivity of the ground surface affects the diffraction, and so also does the question of conductivity in the upper layers of the earth's atmosphere.

*See a paper by Saunders "On the Velocity of Electrical Waves", in the Physical Review for 1896, Vol. 4, page 81. A good bibliography of the subject appears in this article.

†The Transmission of Electric Waves over the Surface of the Earth, by A. E. H. Love, F. R. S., Phil. Trans., R. S., Vol. 215, pp. 105-131, 1915. This paper contains a bibliography of the subject.

There seems to have been only one series of measurements, thus far published, concerning the group speed of radio signals. This series was made in 1913, by a French commission, in a determination of the difference of longitude between stations in Paris, France, and Washington, D. C., with the aid of radio signals.* The great-circle distance between these stations is given as 6175 km. The received radio signals were photographically recorded. The report states that the transmission interval of these waves was found to be 0.021 second. If we assume that this value is exact to the last decimal, the group speed would be $6175/0.021 = 294.050$ km./sec., which is approximately 2 per cent less than v. Probably all that we are justified in inferring is that the difference between the group speed and v was not great.

If the group speed of alternating-current radio signals traveling around the globe did not differ appreciably from v, then because the distance from any point on the earth to its antipodes is very nearly 20,000 km., it follows that the time required for the waves to leave a sending antenna, run around the world and reach the antipodal



James Clerk Maxwell who, in 1867, advanced the theory that light was an electromagnetic phenomenon

antenna, would be $\frac{20{,}000}{300{,}000}=\frac{1}{15}$th second. We must expect the actual time to be a little longer than this. Just how much longer, we cannot know assuredly until measurements over similarly long radio distances have been secured. At present, they are very difficult to secure. It will be surprising, however, if the semi-girdling time exceeds the v-time of 1/15th second by more than a few per cent. It is generally believed that the actual time is not very much greater than the v-time.

It is interesting to reflect that all the nations of the world are thus either actually, or potentially, in probable mutual radio connection within less than one-tenth of a second of time. On a strict v-time basis, they would certainly all be within one-fifteenth second.

It seems unreasonable to expect that we mortals can indefinitely continue to maintain differences of language, of customs, of laws, or of weights and measures, on the surface of a radio deci-second globe. In this thought there is brotherhood and mutual good cheer.

*Comptes Rendus, June 13th, 1916. Vol. 162, pp. 899-903.

Across the Ocean on the NC-4

The Personal Narrative of the Wireless Operator on the Naval Seaplane Which First Spanned the Atlantic in an Historical Air Flight

By Ensign Herbert C. Rodd

I EXPECT that it is up to me to tell, as best I can, just what happened in wireless when the NC-4 made the historic flight across the Atlantic.

The explanation of how the radio equipment was used, and the very great assistance it afforded us, presents no difficulty; but the thing which I find very hard to reconcile with this workaday job is bathing the task in the floodlight of an heroic action. I simply cannot view it that way. The wireless operation of the NC-4's equipment was carefully planned and easily executed; I must say at the start it required no special effort of the superhuman order, as many of the descriptive writers have pictured it. My principal impression of the part I played in the history-making episode is a sense of gratification that the selection of this task happened to fall on me.

The flight in itself was extremely interesting, and I can truthfully say that the success of the wireless communication exceeded all my fondest expectations. If I can convey in this article and its successors, exactly what was accomplished in radio communication during the flight, tell the tale without any embellishments and make the reader understand by inference, more than by power of descriptive writing, how fascinating the manipulation of the apparatus became, then I will feel that the purpose of these articles has been achieved.


Ensign Rodd

Let me first briefly describe the apparatus. The NC-4 had a 500-watt propeller-driven spark transmitter, a 5-watt battery-driven telephone transmitter, an aircraft type receiver and a radio compass equipment consisting of a revolving set of coils operating in conjunction with a compass control panel and an amplifier. Transmission and reception was arranged for either on an antenna stretched between the skid fins on the upper plane, or on a single-wire trailing antenna. The apparatus was located in the aft portion of the boat and was arranged as shown in one of the photographs accompanying this article.

In this photograph the reel of the trailing antenna may be seen to the extreme right. Alongside is the variometer assembly for the spark transmitter. A large special send-receive switch was mounted against the side of the boat; below this on the table may be seen the telephone transmitter and the switch by means of which the amplifier could be used in conjunction with the compass equipment or with the standard receiver. The wave length of 1,500 meters was the one arranged for most efficient operation of the compass. The inter-communicating telephone system was arranged so that the radiophone could be used by either Commander Read, located forward in the craft, or by myself as operator.

During the trans-Atlantic flight I kept a very complete log and this enables me to describe nearly everything that happened, right from the beginning. I am unable to give the exact wave length on which each communication was copied, but it may be generally understood in all that follows that 1,500 meters was used by the destroyers, except when I requested them to transmit on 1,200, 952 or 756 in order to eliminate interference. Communications from the NC-4 were transmitted on a wave length of 425 meters. As we passed each destroyer the time by the clock was immediately broadcasted on 756 meters and this information was then broadcasted by me on 425 meters.

Dispensing now with the earlier preparations preliminary to the actual attempt to fly across the ocean, it may be said that it was on May 6th at 3:30 in the morning when the radio installation on the NC-4 was completed. Within an hour we were expected to make ready for the start, but an unfavorable weather report came in and the flight was delayed, giving me the opportunity to spend most of the day in the boat selecting vacuum tubes for both the amplifier and continuous wave transmitter.

When Norfolk station began on the afternoon schedule, I took bearings, to make sure that the fixed condensers in the radio control panel were adjusted to 1,500 meters. A wavemeter had verified the adjustment, but no tests had been made with the station actually working. The variable condenser in the control panel had a capacity of but .0005; because of the extra weight of larger condensers a fixed capacity was shunted across each variable.

There had been no opportunity to test the radio apparatus in flight, and it looked very much as if the NC-4 would leave Rockaway without knowing whether things would function when the plane took the air. On the following day, however, the weather cleared and at 5 in the afternoon we had everything in readiness to make a test flight. The boat was taken out on the runway and just as we were about to slip down into the water the engineer officer put his foot through the generator's propeller, breaking both blades. This accident was due to the fact that the center engine was running and its tractor propeller had caused the air screw of the small generator to run at such high speed that it was not seen.

A most unfortunate accident also occurred at this time. Chief Special Mechanic E. Harry Howard caught his hand in the propeller, severing the member completely at the wrist. He showed a great amount of grit by refusing to be helped down from the plane, and so challenged our admiration that had it not been our last chance for the test flight, we certainly would have given it up for the day. It was rather rough on Howard to be eliminated from the flight at this late date and we all extended our deepest sympathy to him.

There was no time to be lost, however, as it was

growing dark, and when I told the Navigator that it would probably take fifteen minutes to change the generator air screw, it was decided that we would leave without effecting repairs.

This flight gave me an opportunity to test the continuous wave transmitter with the station at Rockaway. The skid-fin antenna was used and the buzzer signals were easily readable in the air. I found, however, that the telephone did not work to full satisfaction, except when the plane had come to rest on the water with the motors stopped. This was the first time I had tried out the trailing antenna arrangements and the ease of operation of the metal reel surprised me. We remained in the air about two hours, which gave me the opportunity to hear a sufficient number of distant stations with the amplifier and warranted no worry on that score.

The following morning at 4:30 the eventful moment of the start arrived, for it was then that we were awakened and told to make our final preparations for the departure. At 8 o'clock everything was ready; all mechanical and electrical needs had been provided for and food and coffee in Thermos bottles had been put aboard. Especially thorough was the preparation for personal solace in the form of nicotine. Each man had been allowed five pounds for personal effects, exclusive of his flying equipment. Kit bags made of light balloon fabric were provided, and I feel quite certain that had these been weighed after they had been put aboard, they would have found that the limit was well exceeded on account of the generous stock of cigarettes supplied for each man. As a final touch, Captain Irwin presented members of the crew with four-leaf clovers.

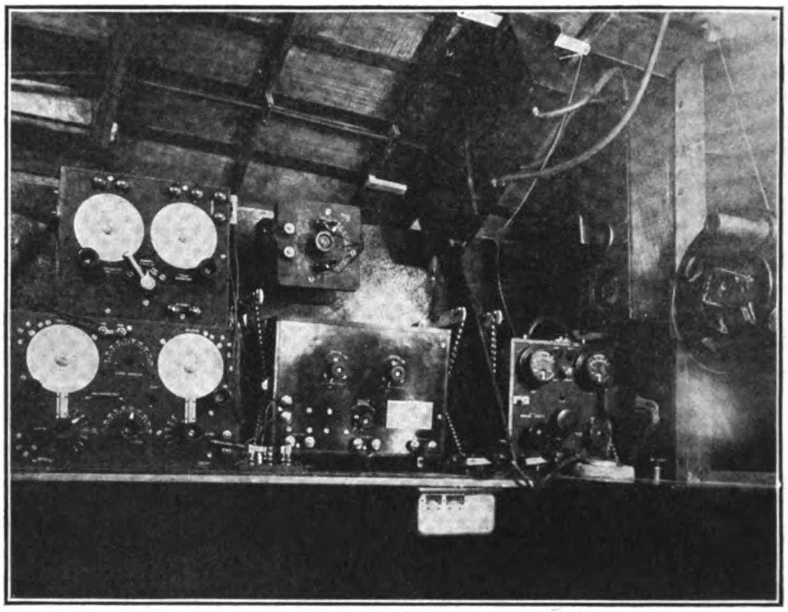
We left Rockaway at 10 in the morning of the 8th of May, my seaplane getting off just after the NC-3 and just before the NC-1. Several other planes accompanied us for a distance of perhaps 25 miles; these were equipped with moving picture cameras and recorded the early stages of the eventful trip.

It did not take me long to get down to business. The immediate result was nearly fatal, for I was ready to jump out of the cockpit with joy when, upon throwing in the field switch and depressing the key, a beautiful spark note greeted my ears through the head phones.

It was a great relief to know that everything was hooked up properly, for I had feared that in the rush, and because of the necessity of working outside of the hangars at night with a poor light, we might have mixed up our power leads. When I adjusted the variometer it showed a radiation of 3 amperes on the skid-fin antenna, and the NC-1 came back immediately, saying that my spark was good. A little personal touch was added then by a good-luck message which came to me through the ether signed by Wise, Jones, Parks and all the rest—radio electricians who had worked to get us in shape.

Twenty-seven minutes after we hopped off, all three of the NC craft had adjusted things and we were in communication with each other. Three minutes later New York and Boston broadcasted that the NC boats had started the trip to Halifax. It was then that I let out my trailing wire.

There seemed to be something doing every minute. Less than three-quarters of an hour after we had started there came a congratulatory and goodluck message from Admiral Coffman, Commandant of the Third Naval District. Within five minutes I received a long message via Rockaway which had come from Admiral Knapp in London, stating that the British Air Ministry had made arrangements to extend every facility and convenience to the NC flying boats at Plymouth when the trans-Atlantic flight had been completed. We were offered the Air Station in the Scilly Islands as a temporary repair or refueling point. I recall that at the time this message seemed a little far fetched, but with it came a feeling of appreciation of the undeniable cordiality of the British and their interest in our success.



The wireless apparatus located in the aft part of the NC-4. To the right may be seen the reel of the trailing antenna, alongside is the variometer; the send-receive switch is attached to side of boat; below that the telephone transmitter and switch for amplifier to be used in conjunction with compass equipment or standard receiver

Fire Island called a few minutes later and wished us good luck. We had then been in the air less than an hour and a half, and I told Rockaway "Everything O. K. 2,000 feet altitude." As I completed this message, I heard Norfolk transmitting on 952 meters, 400 miles distant.

About this time my deep cupped receiving helmet had become uncomfortable and I changed to one which employed ordinary bath sponges, a helmet which had been made at Hampton Roads by Lieutenant-Commander Taylor—one which I had used with great comfort and success during flights totaling several hundred hours. It might be of interest to note here that Commander Read wore the helmet which had been supplied throughout the entire flight, a very creditable performance because pilots have always worn this type of helmet with reluctance, showing a decided preference for the ordinary type which is much lighter.

We passed Montauk after one hour and fifty minutes of flying. It was here that I got a bearing on Philadelphia on the 1,500 meter wave length. It checked up roughly and the signals came in loud on the radio compass. This early indication that the direction finding apparatus was O. K. was very reassuring.

During the next hour I heard the NC-3 working with destroyers No. 1 and No. 2 which lay off Boston and were sending weather reports. New York also asked us to listen for his telephone at 1,200 meters, but it was not audible. Then I heard the operator at Siasconset station asking if we had anything for him. A message from Assistant Secretary of the Navy Roosevelt arrived a minute later.

The next use of the apparatus was of a practical order, demonstrating its value in navigation. The 1 o'clock time tick from the high power station at Arlington came in strongly, and I switched on to the Navigator's phones so that he could check his chronometers. Immediately afterward the air station at Chatham requested our position, and relayed a message from the "Baltimore" at Halifax,

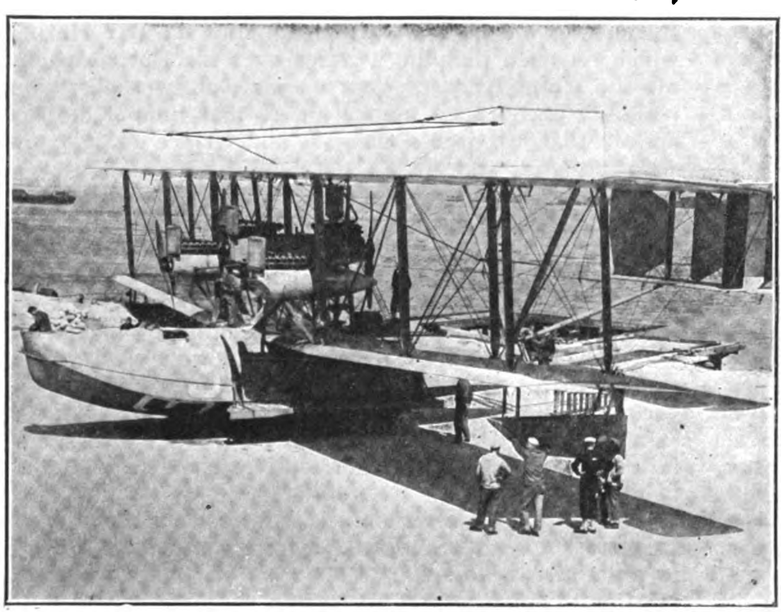
giving weather conditions at that point. This report contained the disturbing information that an hour earlier the northwest wind had a velocity of 37 miles per hour. As this was an important matter for the information of the Navigator, I immediately sent it forward to him.

When we had been in the air four hours and a half the Navigator instructed me to inform the NC-3, our flag-plane, that we had passed over destroyer No. 1 and that we were now running on three motors. In spite of the loss of part of our propelling power we had been keeping up with the other planes, but for some little time it had been noticed that something which looked like oil was streaming out of one of the center motors. Had it not been for the leak here which drained the oil from the forward center engine, we would have made Halifax all right; but when that motor went dead it immediately became evident that with our loss of altitude, which had been rapid, we would not be able to fly far with only two engines in operation. So both center motors were cut off and we glided for landing.

I tried to send during the glide, but could not get a spark, so the destroyers were not informed that we were coming down. The air screw of the generator was located in the propeller slip stream and it was afterward determined that the generator screw turned only when the center tractor was running, showing that the air speed of the NC-4 did not influence the speed of the generator.

The accident which brought us down was the breaking of a connecting rod in one of the motors. A big piece was knocked out of the crankcase and it is still a matter for wonder that no one was hurt and that the pusher propeller was not injured by the flying bits of aluminum.

Immediately after the landing I was given a message to send in the event that I could raise one of the stations. It gave our latitude and longitude and stated that we would probably not require assistance. I called destroyers No. 1 and No. 2 at Chatham, but they were busy on higher wave lengths and I received no reply. I was not surprised at this, because all continuous wave transmitters tune very sharply on the receiving end, especially on the shorter wave lengths. Still, I thought that within an hour or two sombody would happen on our tune. All night long, whenever I noticed an opening, I sent out SOS signals. We were not in any danger but I figured the ordinary call might not attract attention. I kept up the sending on the buzzer, modulated with radiation varying from .5 to .8 ampere, according to filament input. There was no response.



The NC-4 at Rockaway Point receiving the final inspection previous to the trans-Atlantic flight

During the first five hours of the ensuing "taxi" in the light craft, there was a heavy sea running and it pitched the NC-4 about like a cockle-shell.

While we were on the water Bar Harbor and Cape Sable could be heard very plainly working the NC-1 and the NC-3. Communications from ships 300 miles at sea and the responses from stations at New York and Boston were also heard. The practicability of the radio compass was illustrated in one instance by an inquiry from a ship, supplemented by the statement that she had been without astronomical observations for thirty-six hours; New York replied that her signals were Q R Z, and Montauk could hear her on the radio compass.

Our first "casualty" then occurred, the engineer officer became slightly indisposed, necessitating his turning in. The "corpse" looked very comfortable as it lay stretched out on the grating with life preservers used as matresses.

We were able to make about eight knots running on the two outward motors, and although it would have been possible to shift the air driven generator to an outward strut in the slip stream of the propellers, the situation did not seem to warrant it. We were getting along nicely and in making this change I recognized the possibility of putting a foot through the wings or losing a set overboard.

Up to 10 o'clock that night the destroyers could be heard maintaining almost a continuous run of wireless conversation, inquiring whether the NC-4 had been seen and telling each other what course they were patrolling. Their signals came in so loud that they were heard by the Navigator in the cockpit forward, nearly fifty feet away. He suggested that I take bearings on them and determine which one was the nearest, but even though on the skid-fin antenna they could be heard strongly, the transmission was on 756 and 952 meters and the signals were inaudible on the compass coils. This was due to the fact that the range of the compass panel extended only about 200 meters above and below its wave length of 1,500 meters.

An hour after midnight we sighted a ship and signaled with the Aldis lamp, but received no answer. At another time we were within sight of a destroyer, but the operator was apparently not listening in on short wave lengths, for I signaled long and loud with a telephone set without any response. At two in the morning Siasconset's signals were coming in unusually strong, and for an hour I hailed the shore station continuously but could not get the operator's attention. Nor did anything happen when I called Chatham Air Station, but shortly after five in the morning we made the entrance of the channel at Chatham and it was only then that I heard the station there informing the destroyers that the Coast Guard Station had sighted the NC-4. We had established a long distance "taxying" record, having covered 125 miles in fifteen hours.

The boat from the air station came out to meet us and we reached the dock at Chatham two hours later. There we learned that two airplanes had been searching for us without success, probably because they were not carrying wireless operators.

A hearty reception awaited us at Chatham and the officers' mess turned out a breakfast that would be hard to beat. Having disposed of this welcome meal, we instructed the mechanics on the installation of a new motor and then turned in for a few hours needed sleep.

That evening Captain Eaton drove us to the village. It proved to be the town in which Commander Read had lived when a boy, and he pointed out the house occupied by his father, who had been pastor of the church, and he also recognized the school house which he had attended at the age of nine.

We stayed at Chatham for five days, experiencing a regular old Cape Cod Northeaster, with continuous rain and a wind that blew at the rate of 35 miles per hour. There was little to be done to the wireless equipment; in fact, the only attention required was charging the storage battery. This battery had run the 6-tube amplifier continuously for 22 hours, and the continuous wave set for 2 hours—approximately a discharge of 80 ampere hours—with no signs of deterioration. Visits to the plane and thorough inspections were daily occurrences, however, and everything was kept well covered with balloon fabric to protect it from the driving rain.

Although every assistance and encouragement was given by Lieut. (j. g.) T. A. Hoopes, radio officer at Chatham, I must confess that at the end of the fourth day I would have sold at a bargain price my chances of making a trans-Atlantic flight. NC-4 stock went up, however, when on May 13th we received a favorable weather report, supplemented by the information that the weather between Trepassey and the Azores was not favorable for starting. This relieved our anxiety that the other planes at Trepassey might get good weather and hop off without waiting for us.

The following morning, at ten minutes after 8 o'clock, we made a short flight to inspect the propellers and clear an oil line; during the eight minutes in the air I worked Chatham on the skid-fin antenna and was well satisfied that everything would function properly in the operation of the wireless equipment. At 9:07 a. m. we got away, and fifteen minutes later I heard in my head phones the news of our departure being broadcasted by wireless from Boston. A few minutes later the station at Fire Island called the C-5. This call came as a surprise to me, for though we had heard that the dirigible was contemplating a trip to Newfoundland, this was the first intimation that we had that she had started. Twenty minutes later we had passed over destroyer No. 1 and everything went along quietly for about an hour. Then Chatham inquired how much "gas" we had taken on and informed us that the C-5 had passed over that station at 10:10 a. m. A few minutes later I heard Bar Harbor call and tell me to stand by to receive a rush message from Washington, to be answered immediately and relayed to all parts of the world. It was a long weather report which he sent on 600 meters and afterward shifted to 1,400 meters.

This message was followed a half-hour later by a communication from Assistant Secretary of the Navy Roosevelt reading, "What is your position? All keenly interested in your progress. Good luck." In the short space of two minutes the following reply had been sent: "Thank you for good wishes. NC-4 is 20 miles southwest of Seal Island, making 85 miles per hour. Read"

Immediately afterward Chatham asked by wireless for a report for Commander Whiting, giving our total loading, amount of gasoline we were carrying and other details. Hardly had this communication been finished when Bar Harbor radioed a complimentary service message; it read: "Took three minutes for Roosevelt to send despatch to NC-4 and receive your reply. This beats all known records."

The next communication came about twenty minutes later; it was a weather report from Cape Sable. The operator at that station then told me informally by wireless that we looked fine as we flew over. I replied that his station had looked so good to me that I had taken a snap-shop of it, a detail apparently of great interest to him for he immediately requested me to mail him a print of the photograph if it was good. Unfortunately I had only an ordinary vest pocket Kodak with a lense not sufficiently fast, and the picture was a failure. Not knowing the operator's name, I take this opportunity of informing him of the reason why the souvenir has not arrived.

Shortly after noon I started working the Cruiser Baltimore at Halifax, telling them that we would land there for a few minutes, for at that time we expected to keep on to Trepassey. Within a half-hour we had flown over station No. 4 and received his position by wireless. The air then became very "bumpy" and as we were going into Halifax it became very difficult to remain sitting on the small stool with which I was provided; it was almost impossible to send decently. I had managed, however, to tell Bar Harbor that we would land soon and I must say that operator "DN" at that station was certainly a good man on the key; it was a pleasure to work fast with him.

We landed at Halifax without incident, having accomplished the run from Chatham in four hours. For this reason the storage battery still read high, but I observed the precaution of having it charged in the engine room of the "Baltimore." Our intention to remain at Halifax only a few minutes was set aside by the necessity for changing propellers. The type which had been used thus far on the trip was a new one, and the air screws already showed signs of weakening, so it was decided to make a change and to delay the flight to Trepassey until the next morning.

We made an auspicious start for Trepassey at eight minutes to 9 on the following morning, but lack of oil pressure in the center tractor motor forced a landing a half-hour later. It was then that I established communication with the "Baltimore" and the Camperdown station with the small battery set. This apparatus had failed to reach anybody at Chatham, but without any changes whatever in adjustment, it worked these stations very well at a distance which the Navigator told me was 18 miles. Camperdown station, however, could not hear the continuous wave telephone, probably because he had a non-oscillating circuit receiver.

After we had remained on the water for several hours I copied a message from Washington via Bar Harbor which reported that the weather over the European end of the trans-Atlantic course was unfavorable; this certainly encouraged us, for up to that time it did not appear that we would have a fair chance to take off with the NC-1 and NC-3.

We left the water at Story Head at 11:47 a. m., and for something over an hour Baltimore filled the air with message traffic with the station at Bar Harbor. When we were passing Cape Canso, about an hour and a half after our departure from Story Head, the "Baltimore" inquired our position, which I gave him. Immediately, the Canadian stations began to send out broadcasts, requesting all ships to restrict the use of their radio, and each in turn wishing the NC-4 the best of luck. Compass signals followed from destroyers No. 1, No. 2, No. 3 and No. 4, which were all audible and received without difficulty.

At two in the afternoon I sent instructions to destroyer No. 1, the Stephens, reading: "Request change in procedure as follows. As soon as seaplane is sighted, steam on course at full speed and continue course until next destroyer or station reports plane passing." Had this arrangement been in effect at Chatham, it would have solved our difficulties, for back there we had landed just between two ships.

A few minutes later I asked destroyer No. 3, the Robinson, for a weather report and received it in six minutes. Within a half-hour the same message had been sent to destroyer No. 2 and his reply was also received in six minutes.

It was ten minutes to 3 o'clock when we flew over destroyer No. 1 and at that time I was working with the Baltimore at Halifax. Captains Simpson and Lee both sent messages to Commander Read, who replied that he hoped that he had not kept them waiting too long. Im-

mediately the response came back they were not the least bit tired.

At 3:25 in the afternoon we passed over destroyer No. 2, and twenty minutes later had left No. 3 behind. It was about this time that I saw my first iceberg. From a distance the bergs looked like sailing ships, an impression which was also held by Lieutenant Hinton until we had quickly covered the distance to them. I find in my radio log the entry "temperature getting low"—an observation which was made as we passed over the ice floes.

The multiplicity of interesting occurrences during this flight was again emphasized within an hour, when I copied the following message "Navy dirigible C-5 broke adrift from mooring at Pleasantville. Rip cord broke. No one on board. No casualties. Edwards proceeding in a northeasterly direction. Ten persons with instructions to attempt bring down with anti-aircraft fire." It was just about this time the pilots sighted her, but the fact was not communicated to me, so no report was sent by radio.

At 5 o'clock in the afternoon I intercepted a message which was a bit of a shock. We had just passed station No. 4 when I heard No. 3 on the Azores leg tell No. 8 that she could not arrive at the station until 1 a. m., that she was taking No. 3 position. This was our first intimation that the other planes were about to start on the overseas flight.

Ten minutes later our motive power again came into prominence and I sent a message to Commander Towers of the NC-3 at Trepassey requesting that arrangements be made to change our forward center motor. This engine was the one which was installed at Chatham and was of a low compression type. It was just as powerful as the high compression motor which we now asked for, but it was slightly less economical in fuel consumption, and a change seemed advisable.

Within half an hour we made our landing at Trepassey Bay. As we approached the harbor the Aroostook sent me a wireless message to be on the lookout for the NC-1 and NC-3 as we came in. As we had surmised, they had made their start overseas! But our great disappointment was somewhat mitigated when we sighted them, for we then saw that their noses were turned back to Trepassey.

As we glided down to the water with the center motor running I sent a message on the skid-fin antenna, punctuated by the mental hope that the mechanics would be ready and able to give us quick service so that the NC-4 would be ready to start for the Azores with the others.

Good service was forthcoming.

We landed at 5:39 in the afternoon. Immediately mechanics clambered aboard and worked like demons all through the night.

Little was needed in the way of attention to the wireless equipment. The battery was charged aboard the Aroostook, new brushes were put in the spark transmitter, and for rubber gaskets under the cover which had pulled out rubber tape was substituted. There was nothing else required but the elimination of many spare parts which we were carrying and wiping up the apparatus with 3-in-1 oil. Every pound of superfluous weight was removed; bulkhead doors were taken off, and we dispensed with heavy tools and an extra fresh water tank, for favorable weather reports over the entire course were received the following morning, and the start that night became certain.

At 6 in the evening of May 15th we left the water at Trepassey, making a landing a few minutes later to wait for the NC-3. The flag-plane came along within ten minutes took off on the great hop across the Atlantic.

The Aroostook was immediately heard broadcasting the time of our departure and requesting that it be passed down the line to all the destroyers.

(To be continued)

Wireless as an Aid to Aerial Navigation

By Roy A. Weagant

Chief Engineer, Marconi Wireless Telegraph Co. of America

ONE question which has been developed by the remarkable trans-Atlantic flights by aircraft is the great advantages to be secured by utilizing wireless equipment for purposes of air navigation. It is reported that Captain Alcock and Lieutenant Brown employed astronomical observation for obtaining bearings, but I think the flight itself illustrates how unwise it is to depend upon this means of navigating aircraft. It is reported that for hours the moon or stars could not be seen, owing to the dense fog and drizzle. Similar handicaps must be regularly expected, and it is therefore obvious that any consideration of the possibilities of cross-ocean flight on a commercial scale must make provision for navigating instruments that function without visual aid.

There are wireless instruments now available which provide for taking bearings under any weather conditions, and for their universal application it merely remains for the radio and aircraft engineers to get together and work out the details of design within the weight and space limitations imposed by heavier-than-air craft. The layman hardly appreciates that present day airplane wireless equipment was developed under pressure of a supreme emergency and that the apparatus has been adapted to the aircraft which existed, whereas under normal development airplane designers would have made provision for taking care of the wireless equipment features. We can expect normal development now, and there can be no question that under proper supervision air navigation will be greatly simplified and made exact by utilizing wireless aid.

The particular apparatus which makes this possible is the Bellini-Tosi directive system, otherwise known as the goniometer, direction finder or radio compass. The operation of this device is very simple. It comprises essentially two coils fixed at right angles and another coil which is rotated within the fixed coils. This exploring coil is connected to the wireless receiver and is moved through the arc of a graduated scale; when the signals are heard strongest in the operator's head telephone, the movable pointer indicates the direction of the incoming signal. The geographical direction is then secured by a glance at the compass. It may readily be seen, therefore, that if signals can be heard from two wireless stations offering a wide angle, say, Clifden, Ireland, and Lyons, France, the aircraft operator flying across the ocean has merely to make a simple triangulation to get his exact bearings.

The densest fog is no obstacle to the receipt of these wireless signals and it remains but to equip aircraft with long distance receiving apparatus to take full advantage of the aid of wireless in trans-ocean navigation.

In the two epochal airplane flights made thus far there has been no opportunity to determine the full value of the directive system of wireless. The American NC flying boats employed the device, but only with short

range receivers, as the flight commanders expected to remain within easy receiving distance of the line of destroyers. Had long range receivers been installed the craft would not have had to depend upon these ships for bearings. The same is true of the Vimy airplane, and it will be interesting from a scientific point of view to compare results when in some future flight full advantage is taken of the obvious value of the long distance receiving apparatus.

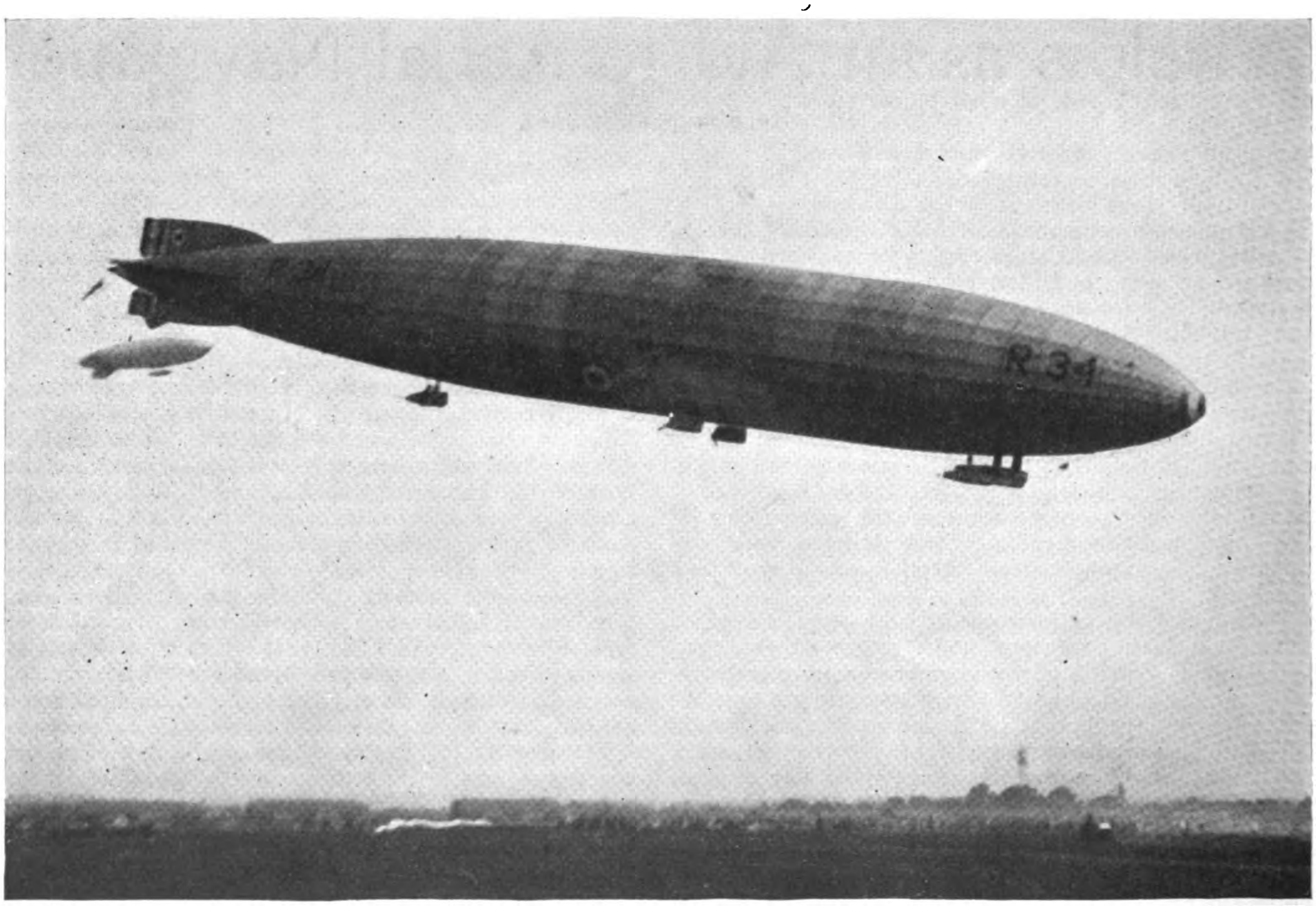
In the speculation regarding the eventual establishment of regular ocean crossings by airplane, account should be taken of the entire feasibility of setting up a wireless path or lane which will enable aircraft to remain on a course in weather when astronomical observation is impossible. To maintain such a path would require merely that three high power wireless stations transmit signals regularly at frequent intervals and that a wide angle be afforded by their geographical position; thus one station in America, one in Europe and one in Africa would be sufficient to guide aircraft on their courses both ways across the Atlantic. Maintenance of these wireless stations for that exclusive purpose would perhaps be prohibited by the expense, but in the not far distant day when trans-Atlantic aircraft will be making daily flights across the sea, the expense, equitably distributed among the air transportation companies, would be negligible. Up to that point, however, it is reasonable to suppose that arrangements could be made so that the three wireless stations could suspend other message traffic operations on the "sailing" days and maintain their paths of signals during the hours when the flying crafts are crossing the ocean.

It may be well to point out also that we have just begun to employ wireless transmitting apparatus on airplanes. In the course of normal development it is to be expected very soon that wireless telephone conversations will be held between aircraft and ships at sea. It then becomes a simple matter for the aviator lost in a fog to get the latitude and longitude from two vessels, determine their direction by the Bellini-Tosi system and know almost instantly his exact position. Another step which is certain of accomplishment is the utilization of wireless as a means of summoning aid if the aircraft is forced to descend on the water. The wind-driven generator which is now in universal use on airplanes does not function unless the craft is in full flight. A generator driven from the airplane engine is therefore essential so that wireless transmission may be effected when the craft is resting on the water. The design of a satisfactory engine drive and provision for charging storage batteries for use when the motor is not running presents no engineering difficulties. This problem, and several others which are not yet worked out to the full satisfaction of radio engineers, are comparatively minor matters when it is considered that in less than a year airplane wireless apparatus has been developed which has a sending range of 600 miles and ability to receive 1,400 miles. It but remains for wireless equipment to be recognized as indispensable for aircraft as it is for ships, a matter which will be appreciated by aviators when they have had the opportunity of properly employing it as an invaluable navigating means as well as a method of summoning assistance.

Wireless Direction Finder the Secret of Alcock's Success

HOW did Captain Alcock navigate his airplane across the Atlantic Ocean through more than a thousand miles of fog and sleet so successfully? How was his navigator, Lieutenant Brown, able to steer the machine to the exact point in Ireland that the two airmen had announced as the terminus of their flight?

"There is not one chance in a million of being able to reach the destination with such accuracy by the ordinary instruments of navigation," says Grover C. Loening,



Press Ill. Svce.
The R-34 hovering over Roosevelt Field, Mineola; this dirigible made two successful cross-ocean flights by using wireless as a navigating aid.

monoplane manufacturer. "Under the weather conditions experienced by Captain Alcock the airplane should have been miles out of its course.

"His story of the flight shows that winds were experienced first from the northwest and then from the southwest. With the fog and sleet that prevailed it was impossible for the navigator even to estimate the drift caused by these winds. His ordinary means of navigation were useless."

Reliable reports state that the apparatus installed on the Vickers biplane was built into the wings of the machine. It was absolutely independent of the other wireless apparatus.

The direction-finding coils were built into the wings, so that when the machine was pointed toward any wireless station signals would be received from that station. Should the machine veer to the right or left signals would immediately cease recording on the receiving apparatus.

So simple in operation is this apparatus that it is also unnecessary for the pilot to understand the signals being sent out. As long as he hears the signals in his telephone headgear he knows he is heading directly toward the wireless station chosen.

This, it is said, is exactly what occurred in the Vickers-Vimy bomber's flight across the Atlantic. The Clifden wireless station is the largest in Ireland, and is in constant communication with Glace Bay, in Canada. The Vickers crew throughout their voyage were able to hear this station, and thereby keep their machine directed toward it, and so overcome the effect of the side drift caused by the winds. This would explain why the machine finished its remarkable voyage right over the tremendous aerials of the Clifden station.

The Radio Compass and the NC Flights

THE NC-1 went to the bottom of the Atlantic and the NC-3 was forced to plunge into the sea during the historic flight from Trepassey Bay, Newfoundland, to Ponta Delgada in the Azores because the radio compasses on the two planes failed to record messages sent from a greater distance than ten miles, and not because they were forced down by storm and fog.

This statement was made by Commander John H. Towers.

Commander Towers's remark concerning the failure of the radio compass, or direction finder—something new to aerial navigation—was the result of a statement made by Commander Read, who had been asked how he happened to reach the Island of Flores under the same atmospheric conditions experienced by the pilots of the other planes.

"I call it just good luck," he said. "I got through the fog bank and caught one glimpse of land. Of course, I knew what the land was and headed for it. I never have been able to understand why the others had worse weather. One was to the north of me and the other to the south of me. Reports received by wireless indicated that the fog was less dense to the south. I was in the centre of the sandwich, so to speak."

"That is perfectly true," said Commander Towers in discussing this point. "Both Read and I were south of the course, which lay between the Islands of Corvo and Flores. When I was off Flores I too got one flash of the sun and made an observation, but I didn't trust it. Later, I wished I had as it would have saved us fifty-six hours in the water.

"It was about that time that the engineer informed me we had but two hours of gasoline and I decided to descend to the sea."

"Then you were not forced down by the storm or fog?" he was asked.

"Not at all," replied the commander after a slight pause. "The plane—all of them, in fact—could have withstood the storm and fog nicely. We came down because we didn't know where we were, and could not afford to take chances with so limited a supply of gas."

"But you were supposed to know by means of your radio compass."

The commander paused for a considerable time.

"I'll be perfectly frank with you," he said finally. "That was the whole trouble—not the fog and unexpected storm. But I want to say right here that the most valuable result of the flight, scientifically speaking, was the demonstration that the radio compass is most remarkable. It will make air travel over the ocean feasible.

"The difficulty did not lay in the fact that the compass

An unconventional portrait of the unfortunate Commander Grieve, in the safety suit which he wore when rescued. It will be recalled that, after being saved with Hawker, he remarked: "The future of navigation of the air undoubtedly lies with directional wireless"

was imperfect, but in the fact that under the system of installation on the planes it was confined to a radius of ten miles. With proper installation it would have recorded signals sent from a distance of 150 miles. We knew the limitations before we got to Halifax. We also were aware that it would require at least a week to make the necessary changes.

"We discussed the matter and decided that in view of the favorable weather reports we were not taking much of a chance in starting with the inefficient radio compass.

"So we started, ran into a storm, and two of us had to come down for the reasons I have given. If we had known just where we were we would have kept right on as we had gas enough for the trip. It was the compass alone which caused two of the three boats to fail."

"There is one impression I wish you would correct," he said. "Our wireless did not give out. We continually sent messages asking for aid after we had come down onto the water, but the ships and shore stations were so industrious asking our position that they couldn't hear us. We couldn't get a word in edgewise."

Getting back to the radio compass, the commander wanted to make it very plain that he advocates it strongly. He repeatedly said it was the greatest discovery yet made in aerial navigation, and as often asserted that with proper installation his would have met all requirements.

Inductively Coupled Transmitter for Extremely Short Wave Lengths

IT appears that a considerable amount of research work on extremely short wave transmitters has been carried on abroad. Many problems are encountered in the design of such sending sets. This will be evident from the following brief review.

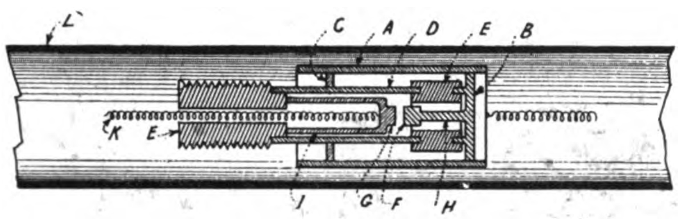


Figure 1.—Longitudinal section of the short wave inductively coupled transmitter

In the well-known Marconi type of coupled circuit transmitters, the primary circuit comprises three elements, (1) a condenser (2) an inductance, and (3) a spark gap. The energy which can be supplied per discharge to such a primary circuit depends upon the capacity of the condenser and the potential to which it can be charged, and therefore to obtain the maximum energy capacity the condenser should be of the greatest capacity possible.

The decrement of the circuit is proportional to the ratio of the high frequency resistance to the inductance. The losses due to the high frequency resistance are (a) losses at the spark gap, (b) losses in the condenser, and (c) losses in the conductors, a large portion of which is caused by eddy currents due to unequal distribution of the magnetic flux in the conductors. Practically these losses cannot be entirely prevented, but they can be greatly reduced by employing special forms of spark gap, air condensers, and a large amount of stranded copper in the conductors.

In order to make the decrement of the circuit sufficiently small, it is essential that the inductance be not too much reduced, and this necessitates that for any particular frequency the condenser shall have more than a certain capacity. For the frequencies usually employed in wireless telegraphy—1,000,000 down to 20,000—it is not difficult to arrange the elements of the primary circuit so as to insure sufficient energy capacity with small de-

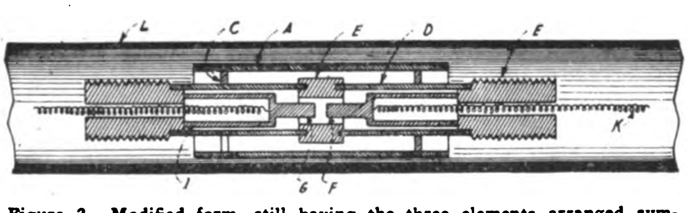


Figure 2.—Modified form, still having the three elements arranged symmetrically about a common axis

crement, but for frequencies of the order of 100,000,000—three meter wave length—it becomes very difficult to arrange the elements so as to insure a similar result. C. S. Franklin of London has devised a special transmitter in which each of the three elements of such a circuit is arranged symmetrically about a common axis.

Figure 1 is a longitudinal section through the common axis while figures 2 and 3 are similar views of modified forms.

In figure 1, A is a metal cylinder, one end of which is closed by a metal disc B, while the other end is closed by a metal ring C and a co-axial cylinder D mounted between insulating blocks E. The ring C can be slid within the cylinder A for tuning purposes. The cylinder D is filled with gas under pressure. F, G, are the spark electrodes, F being carried on a rod H secured to the center of the disc B, and G being carried by a third cylinder I. K, K, are choking coils through which the condenser formed of the cylinders D, I is charged. The circuit comprises the condenser formed of the cylinders D, I, the spark gap, rod H, disc B, cylinder A and the ring C. The antenna consists of one or more rods L arranged parallel to the common axis of the cylinders and close to the outer surface of the cylinder A, the closeness of the coupling depending upon the proximity of these rods to the cylinder.

In the modification shown in figure 2, there are two cylinders D, D, insulated from each other by blocks E, two rings C, C and two cylinders I, I. The oscillating

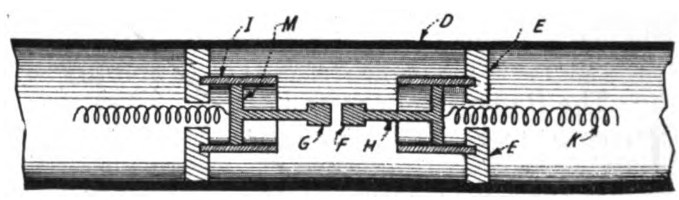


Figure 3.—The simplest construction and the most suitable for short waves

circuit here comprises the two condensers formed of the cylinders I, D, the spark gap, the rings C, C and the cylinder A.

In figure 3, which shows the simplest construction and that most suitable for very short waves, there are a cylinder D, and two cylinders I, in each of which there is a disc M supporting a rod H carrying an electrode, the three cylinders being of course, mounted on a common axis while the cylinder D, acts not only as one plate of the condenser, but also as the antenna.

The high frequency circuit can be traced in each of the three arrangements as follows: In figure 1, it runs from the spark terminal F through the rod H to the disc B, through the coupling cylinder A, to the disc C, to the cylinder D, by condenser action to the cylinder I, to the spark terminal G.

In figure 2, it runs from the spark terminal F, to cylinder I, by condenser action to cylinder D, to the disc C, to the coupling cylinder A, to the second disc C, to the second cylinder D, by condenser action to the second cylinder I, to the spark terminal G.

In figure 3, it runs from the spark terminal F through the rod H to the right disc M, to the right hand cylinder I, by condenser action to the coupling cylinder D, by condenser action from cylinder D to left hand cylinder I, to the disc M and through the left hand rod H to the spark terminal G.

It will be seen that the high frequency oscillations do not pass through any coils at all, the only inductance in the high frequency circuits being that of straight rods and cylinders, and it will be seen that all the parts enumerated are all coaxial with the spark gap.

Artom's Visual Receiver for Directive Wireless Telegraphy

THE detecting device in Artom's system is built somewhat in the form of a d'Arsonval galvanometer. The movable coil is traversed by rectified high frequency currents fed by directive aerials. The coils are disposed vertically and are free to turn around a vertical axis; their angular disposition is similar to that of the vertical planes containing the directive aerials. The coils are disposed as shown in figure 1, one beneath the other; they are rigidly connected and pivoted, or suspended in any other suitable manner.

shown by K and K'. The terminals 1, 1' and 2, 2' connect the instrument with the directive aerials X and Y.

The constructive forms which the invention may assume in practice are numerous and they vary according to the type of the detector or rectifier of electric waves which are used. The following are the three preferred forms:

(1) In the circuit's movable coils AB and CD two thermo-couples are inserted. Two resistances of manganin or of any other suitable material are traversed by

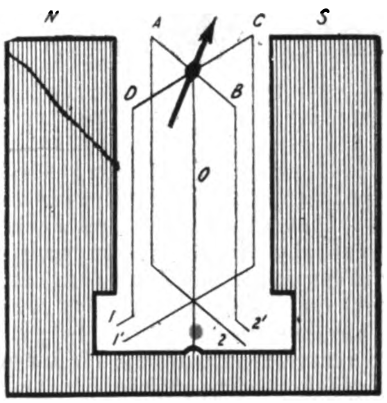


Figure 1

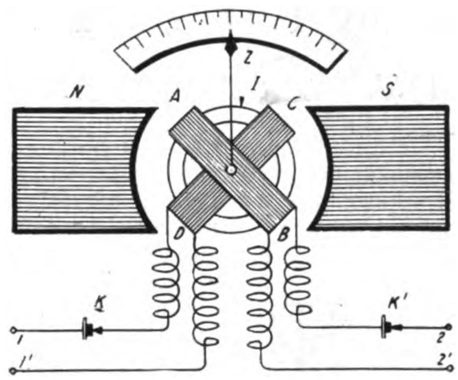


Figure 2

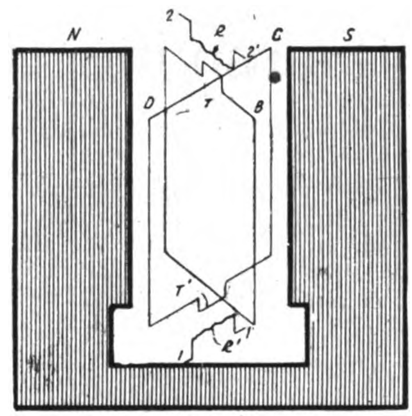


Figure 4

Figures 1 and 2 show the disposition of the meter coils. Figure 4 is a diagram of the thermo-couples

The oscillatory currents induced in the aerial conductors, before traversing the coils flow through the syntonized circuits comprising a detector which may be either of the crystal or of the electrolytic or ionized gas type, or of the magnetic, thermal, or thermo-electric type. They are transformed from oscillatory to rectified currents or to currents having the preponderance of current in one direction.

The coils may be arranged in circuits provided with thermo-couples operated by heaters in the oscillatory circuits, in which case the thermo-couples act as in Boys's micro-radiometer. The coils may be of thin wire like galvanometer coils or may be made with a thicker wire, like ammeter coils. When the rectified currents traverse the coils, magnetic forces are produced by the action of the magnetic field, which cause the movable system formed by the coils to be deflected and such deflection can be shown either by an index or a scale mirror.

The tangent of the angle of deflection depends upon the ratio of the values of the currents traversing the coils, these values being proportional to the currents in the aerial conductors of the receiving station. The deflection depends upon the direction from which the radiating waves arrive. A graduation made once for all shows exactly the direction from which the electric waves arrive, provided the quadrant from which they are transmitted is known.

Figure 1 and figure 2 of the accompanying drawing show diagrammatically the disposition of the galvanometer coils. Figure 3 is a diagrammatic view of the circuit connections of a modified form of the system. Figure 4 is a diagrammatic view illustrating the use of thermo-couples. Here NS is the magnet or electro magnet. AB and CD are the coils which are rigidly connected to each other and which are revoluble on the central axis O. An index Z is attached to the coils. A stationary soft iron cylinder I is disposed in the fields so as to reinforce the action of the magnetic field of the rotating coils.

The detectors or rectifiers of the electric waves are

the oscillatory currents coming from the directive aerials. The thermo-couples produce in the coils AB and CD rectified currents which cause the coils to take up a definite position in the stationary magnetic field.

(2) When tubular detectors or rectifiers of the ionized

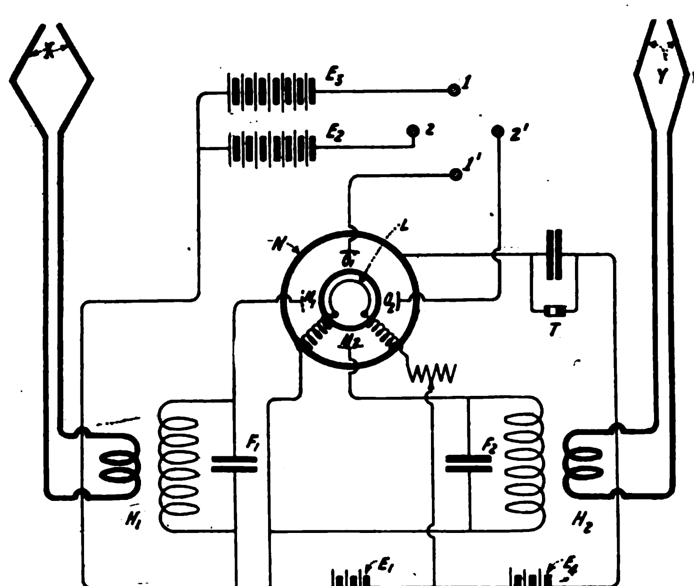


Figure 3.—A horizontal section of the tube and the circuit connections

gas type are used, one of the tubes may be provided for each directive aerial. In order to indicate with the greatest accuracy the direction from which the electric waves arrive, the particular form of tube for ionized gas shown in figure 3 can be used with good results. The figure shows a horizontal section of the tube and the circuit connections.

The incandescent filament L is placed in the central part of a glass tube having a spherical or cylindrical form,

provided at the periphery with the cylindrical plate N for the reception of the telephonic signals. M^1 M^2 are metallic grids: O^1 O^2 are metallic plates connected respectively to the leads of 1′ and 2′. The latter are connected to the galvanometer coils as shown in figure 2.

The position of the grids M^1 M^2 relatively to the plates O^1 O^2 and to the filament is not necessarily that shown in the drawing but may be changed to other positions. The battery E^1 is a source of energy for the filament L, the batteries E^2 and E^3 energize the space between the incandescent filament and the conducting plates O^1, O^2, E^4 transmit current across the ionized space between the filament and the cylindrical plate N to energize the circuit of the telephone T. F^1, F^2 are capacities inserted in the oscillatory receiving circuit of which H^1 and H^2 represent the oscillation transformers, that is to say, the primary coils of the transformers H^1 and H^2 are connected at xx-yy to the directive aerials.

(3) When a detector of the electrolytic type is used, a single vessel containing acidulated water or other suitable liquid may be employed wherein the electrodes for both or all the detectors are immersed.

In figure 4, there is shown diagrammatically the arrangement of the thermo-couples. In this figure NS is the magnet, AB and CD are the galvanometer coils, T and T′ are the thermo-couples and R R′ are thin strips of gold leaf or manganin which are connected with the directive aerials and act as heater elements.

A Transmitter Designed to Radiate Waves of Low Decrement

TO render the receiving apparatus of a radio system most effective, the impulses impressed upon the receiving circuit should occur at the rate of approximately 1000 impulses per second, which corresponds to the frequency or pitch of a tone of good audibility. To insure

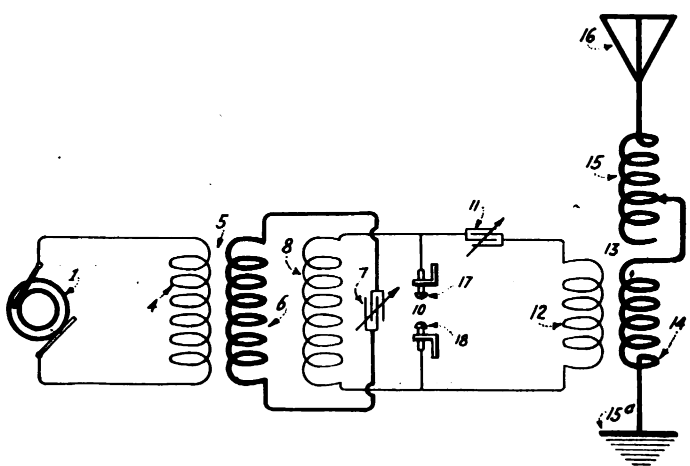


Figure 1.—Diagram of transmitter for generating slightly damped waves

uniformity in the production of the tone in the receiving circuit and also the production of a note having a constant pitch, these impulses should be produced at regular as well as frequent, intervals. Moreover, the loudness of the tone produced in the receiving circuit depends upon the amplitudes of the impinging wave trains. This last property is secured over long distances by generating wave trains at the sending station that are only slightly damped or possess a low decrement. It is apparent, therefore, that the wave trains originating in the sending station should be produced at regular intervals and with suitable frequency, as well as with high initial amplitudes, in order to radiate from the antenna a series of wave trains that may be projected over wide spaces and be instrumental in producing in the receiving apparatus audible notes of constant pitch or uniformity.

C. L. G. Fortescue claims that the transmitter shown in the accompanying drawings generates waves that are only slightly damped. At the same time, the wave trains projected into space may be produced at a high rate and uniform frequency in order to insure the production of a uniformly pitched and audible note in a distant receiving station.

In figure 1, a source 1 of alternating current is connected by conductors 2 and 3, to a primary winding 4 of a transformer 5. One secondary winding 6 of the transformer is connected in a closed circuit with an adjustable condenser 7. The windings 4 and 6 of the transformer are magnetically linked closely with each other. The capacity of the condenser 7 is so chosen that its effect in the circuit comprising the primary winding 4, will under certain circumstances, completely compensate for the inductive reactive drop in the circuit when subjected to the flow of alternating currents having the frequency of those generated by the source 1. In other words, the circuit comprising the primary winding 4 may operate, in certain instances, at unity power-factor since the condenser 7 will completely compensate for the inductive reactance created therein.

A secondary winding 8 of the transformer energizes the high frequency oscillating circuit 9, which comprises a spark gap 10, an adjustable condenser 11 and a primary winding 12, of an oscillation transformer 13. A secondary winding 14 of the oscillation transformer has one of its

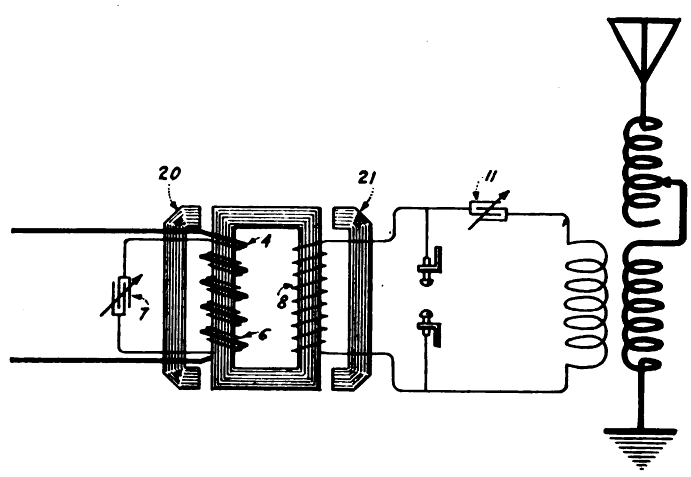


Figure 2.—The structure for obtaining the desired relations of the transformer windings

terminals grounded at 15 and the other connected, through an adjustable inductance 15, to the antenna or electrical wave radiator 16. The windings 8 and 4 of the transformer 5 are magnetically linked loosely with each other and, therefore, a leakage flux will obtain between the primary or inducing winding 4 and the secondary winding, under certain operating conditions.

Again, if proper quenching of the sparks generated by the oscillation producer 10 is effected, the oscillations in the circuit comprising the primary winding 12 will discontinue after a very short time interval. The sec-

ondary circuit, therefore, will continue to oscillate at its natural frequency and with its natural damping just as if the primary circuit did not exist.

The capacity of the condenser 11 is so chosen that the circuit comprising the secondary winding 8 and the primary winding 12 of the oscillation transformer is in resonance with the circuit comprising the primary winding 4 of the transformer 5, when the oscillation producer 10 is inactive. In other words, series resonance conditions are established between these two circuits, since the condenser 11 inserts a condensive reactance that resonates with the inductive reactance inserted by reason of the leakage flux obtaining between the windings 4 and 8.

The condenser 7, by reason of its association with the winding 6, compensates for the inductance obtaining in the circuit of the primary winding 4 only when the spark gap 10 is active. As a result, the maximum flux threading through the primary winding 4 occurs with the maximum voltage or the peak of the alternating current wave generated by the alternator 1, when the condenser 11 is rapidly charging and discharging through the gap 10.

When the voltage in the secondary winding 8 is sufficient to break down the spark gap 10, the condenser 11 will discharge through the gap, thereby generating high frequency oscillations in the oscillating circuit 9. Simultaneously therewith, the secondary winding 8 will be short circuited by the gap. At the same time the circuit comprising the primary winding 4 will operate at unity power factor by reason of the action of the condenser 7. The value of the flux generated by the primary 4 is, therefore, independent of the conditions obtaining in the high frequency oscillating circuit 9.

When these conditions exist, the voltage induced in the secondary winding 8 is likewise coincident in time with the magnetic flux generated by the primary winding 4, because the circuit comprising the short circuited secondary winding 8 is in resonance with the circuit comprising the primary winding 4. In other words, this combination of circuits is tuned to the frequency of the source of supply 1.

In figure 2, there is shown diagrammatically, a structure for obtaining the desired relations between the windings 4, 6 and 8 of the transformer 5 of figure 1. It will be noted that the primary winding 4 is disposed on the same core leg as the secondary winding 6. The windings 4 and 6 are, therefore, closely linked magnetically with each other. The secondary winding 8 is disposed on a second core leg. Magnetic shunts 20 and 21 provide means for increasing or varying the magnetic leakage between the primary winding 4 and the secondary winding 8. By properly positioning the magnetic shunts 20 and 21, series resonance may be established between the winding 4 and the winding 8 in combination with the condenser reactance element 11.

Methods of Signaling with Arc Transmitters

SIGNALING with arc transmitters has heretofore usually been effected by varying the wave length of the radiated wave. This has been done by short circuiting a portion of the inductance, but in high powered stations the current in the short circuit is large, which makes it a difficult problem. Leonard Fuller has recently shown another method in which there is provided an oscillatory circuit, figure 1, containing an inductance 9 and a capacity 12 and an energy consuming reactance which is controllable to vary the losses occurring therein. This circuit is shunted around the source of oscillations or arc 2.

When an arc is shunted by two dissimilar oscillatory circuits, it will oscillate upon one circuit or the other, but will not oscillate upon both at the same time. It will in fact oscillate upon the circuit most agreeable to arc conditions, to the total neglect of the other. By varying the reactance of the shunt circuit, this circuit is chosen or neglected by the oscillations, and consequently the radiating circuit is either neglected or chosen according to the manipulations of the key.

The energy consuming element comprises a core 14 formed of stiff iron laminations, which are chosen to provide a large hysteresis loss, especially at high frequencies. A coil 15, forming part of the shunt oscillatory circuit, is wound on a portion of the core. The current in the coil produces a flux in the core, which causes a loss of energy due to hysteresis. By reducing the hysteresis the losses are reduced, so that the oscillations will prefer the shunt circuit to the neglect of the radiating circuit. This loss may be reduced by subjecting the iron core to a M.M.F. produced by a direct current coil 16, which is wound on a portion of the core and arranged in circuit with the battery 17. A key 18 arranged in the battery circuit provides means for opening and closing such a circuit.

Choke coils 19 are preferably arranged between the battery and the coil 16 to prevent the high frequency current generated in the coil from passing into the battery. Other means to accomplish this result may also be used. The size of the coil and battery are preferably such that when the key is closed, the core is saturated, thereby reducing the hysteresis and hence the losses in the shunt circuit. Due to the losses, the core becomes

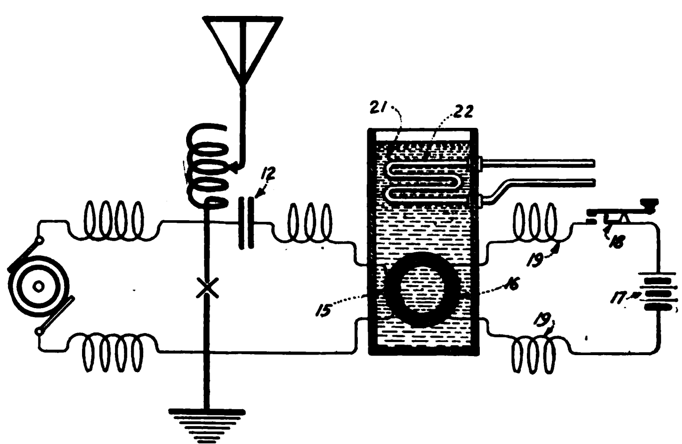


Figure 1.—An oscillating circuit containing an inductance, a capacity and a reactance shunted around the arc; used in Fuller's method of signaling with arc transmitters

heated and in order to dissipate the heat, the core is immersed in an oil bath 21 through which pipes 22 carrying cooling water pass.

Signaling is accomplished by opening and closing the key 18; closing the D.C. circuit serves to reduce the hysteresis and hence the losses in the shunt circuit, thereby causing the arc to oscillate upon that circuit to the neglect of the radiating circuit and opening the D.C. circuit, causing an increase in the losses in the shunt circuit and thereby causing the arc to oscillate in the radiating circuit.

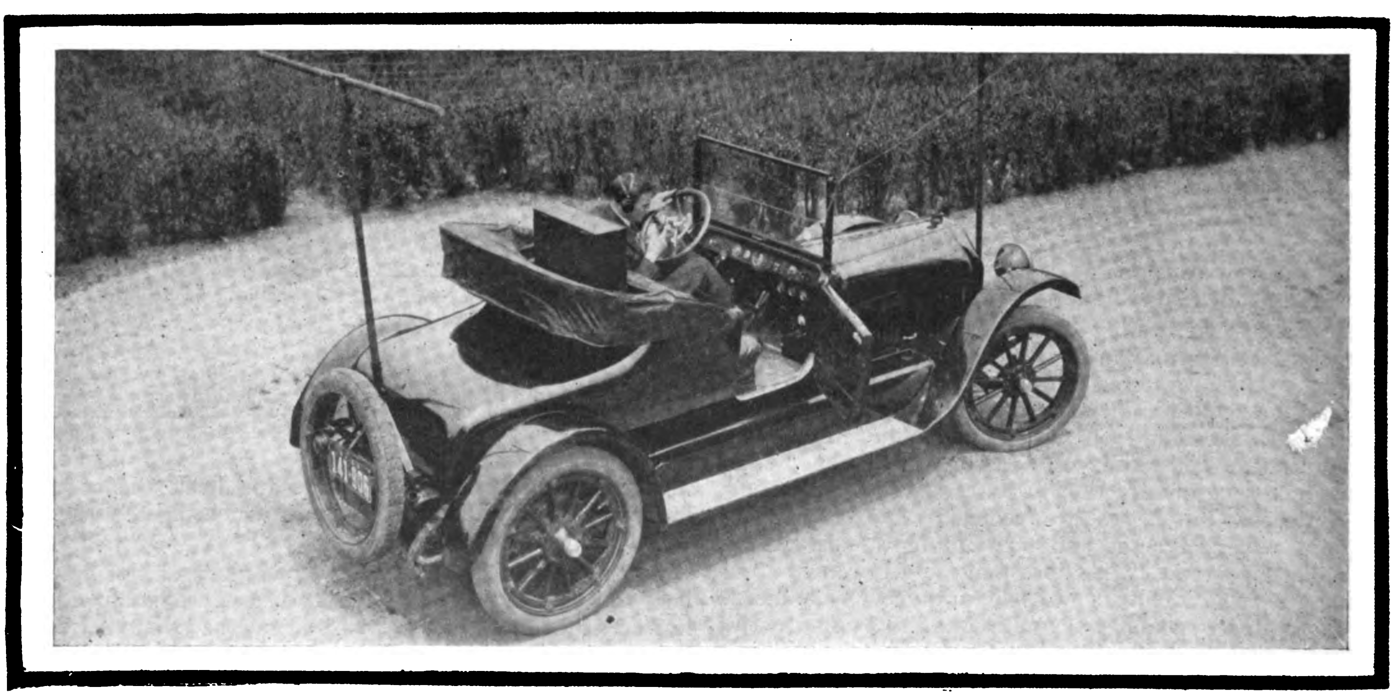
(c) Press Ill. Svce.

Wireless On Wheels

The radio telephone has been successfully used on airplanes and small craft, but the adaptation to the automobile is novel and presents a field for future possibilities

The radiophone equipment shown above is capable of keeping in telephone communication with another station for a distance of from 15 to 20 miles and with its emergency radio telegraph it can communicate as far as forty miles

The transmitting apparatus (on the left) is of the latest type, employing vacuum tubes as generators of radio energy, while the receiver is a highly developed device with enclosed regenerative circuits and amplifiers which enable communication to be maintained long after the signals become too weak to be heard without these new devices



The antenna equipment is compact and may be slung under the running board on hooks provided for that purpose. In the photo it is shown above the running board as it cannot be seen very well when it is in the proper position under the running board

A Summer on the Great Lakes

The Second of a Series of Impressions of a Novice in Commercial Wireless Operating

By Julian K. Henney

II—Such Is Life

"WHAT a wonderful thing wireless is! I simply don't see how it works."

Every time some talkative passenger came to the radio room of the Juniata that summer, and started the usual line about how interesting and wonderful is wireless, I thought of that first night and the day following. And as I sat there on the stool that had been Jones' undoing, I thought too, how wonderful — and fearful — the new art of radio communication had been.

Snell won the first watch by the toss of a penny and I turned in. At two o'clock he awoke me to finish the night, or to stand by until relieved, should our friend come to.

When I turned out of the warm bunk and bundled up in more clothes, I noticed at once that the waters had calmed a bit, although the wind was still whistling in the rigging above us and the four huge stacks were booming away in an awesome manner. There was still quite a bit of roll and the chairs were trying their best not to get dizzy and fall under the table. As I climbed to the high stool, the pinnacle from which Jones had ignominiously fallen, I mentally prayed that I might be spared a similar fate.

I saw at once that it was no wonder that seasickness had overtaken the wireless man of the Seeandbee. That stool was about the worst thing imaginable that one could be perched upon in a gale. Like the old three-legged milking stool that used to grace every cow shed in farmland, it simply would not stand still. With every lurch of the ship—they came less frequently now, thank Heaven —I threw out my hand to keep from falling against the opposite wall; both feet went out in the same direction, too, on those occasions when I was able to get them untangled from the rungs of the blooming stool. The receivers clung to my ears tightly and only served to accentuate the dull roaring outside and the groan of the stacks above. That morning watch promised to be anything but delightful.

Signals soon came in, however, and they served to distract my attention from the swaying of my seat. They were the first I had heard since my amateur station had been closed because of the war emergency, so I was all eagerness to hear them again. First came a few buzzes in familiar tone. It was like hearing from an old friend, for the station sending was a D. & C. boat plying between Toledo and Mackinac, on which I had once served as operator. Next came a coarse resonant rumble from far away Calumet. That these signals should be received, clear down in Lake Erie, was a surprise to me, but when Cape Hatteras started coming in with his old high-pitched, earsplitting racket, I began to realize the effectiveness of the tall masts of the Seeandbee. Several other stations were picked up—one sending out submarine warnings, another talking in code—and then, just before Jones relieved me, I made the acquaintance of Snell's friend Dietsch of the Detroit Third. He called to say good morning and to ask if we had any business for him. I came back with a good strong "nothing doing" and a good morning, and turned around to see Jones staring. We had a little friendly confab and he apologized for robbing us of our sleep, before I turned in. It was five o'clock by my watch, and at eight we would be in port!

From the very start of that first day we began to realize how interesting wireless could be. We lugged our cargo of freight—the hand trunk of mine; the suitcase with a lifetime outfit in it; the mandolin; the straw hat and Snell's kodak—down three flights of stairs and across the gangplank. At the end of the plank a sleepy-eyed officer took our blue passes and cursed us heartily because we laughed at him. He looked as if he had put in a wild night of it, and when we smiled he hastened to explain that he had been up with a sick passenger. This of course amused us still more so instead of only smiling, we laughed outright. Thereupon the officer invited us to ride to a place much warmer than the Seeandbee on a stormy night. The reception committee appeared to be constructively, on the job. Our friend of the sardine sandwich and the ginger ale, looking as though he were the sick passenger, then came out and he joined the assistant purser in his malediction.

We figured that we could lug our stuff to the Juniata, get it stowed away, see that things were shipshape, and then hike to town for something to eat. We needed it; neither of us had had a thing to eat except the shredded wheat of the night before.

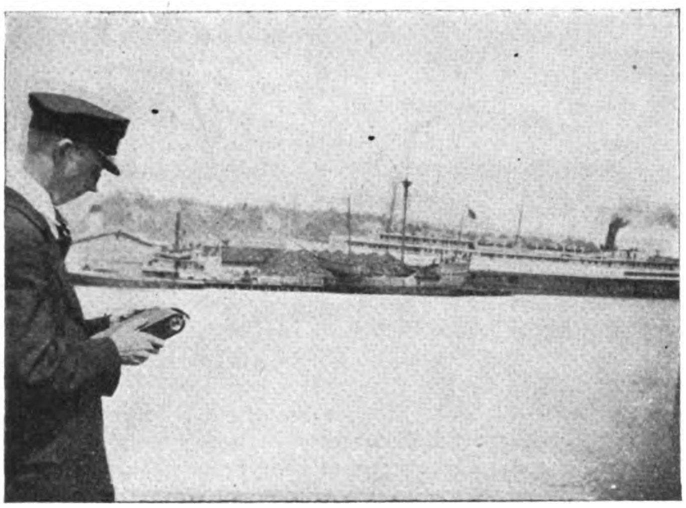
The newly painted funnel of the vessel that was to be our home for the summer, loomed up through the early morning mist and fog, astern of the Seeandbee, and the ship looked mighty good to us after the experiences of the night we had spent on the sidewheeler. Three masts and the brightly shining red copper wire of a new aerial beckoned to us across Buffalo's alleged river as we gazed upon the white and spotless decks and the green waterline of the Juniata. It was to be our home for a good many days after that, and there were to be times when we would give most anything to be able to get off for a few days and sleep in a real bed that did not shake and tremble all night long. But at the present time we were full of youthful enthusiasm, full of spirit that seemed indomitable; as full of curiosity as if we were to play with a new toy for the first time. The red smoke stack and the pure white steam rising from behind it invited us to hurry aboard and get acquainted.

As the sun began to penetrate the mist which is common to lake ports in the early morning, we walked across the bridge to where the Juniata was tied up alongside an old warehouse. My traveling bag was heavy—have I emphasized that fact before?—without anything in it,

its weight was enough to stagger a man. I had stocked it for a three months' stay. Snell was burdened with three times as much stuff. We were somewhat warm when we arrived at the warehouse.

I wondered at the time what in the world Watson could have in his suitcase. Had he brought a private wireless outfit of his own or only a few hundred pounds of sugar for his personal use during the summer? I found out later I had overestimated the capacity of that heavy affair. It only held two suits of clothes, a uniform, a half dozen pairs of shoes, a library of seven or eight volumes, several portfolios of mandolin music, an innumerable number of films, all of the usual run of heavy clothing that mothers continually load on disgusted sons, and several reams of letter paper. In one small suitcase! There certainly was reason for Snell's belabored breathing on that muggy July morning.

So we lugged and lugged, and lugged some more. At about every third step, one of us would give out and stop for breath. Watson would change the kodak to the left hand, pick up the wardrobe with the right, and leave the mandolin on the ground. He would look disgusted



Evidence of the existence of the troublesome kodak that marred the early pleasures of two enthusiastic wireless operators

with the world in general, mop his face, and valiantly start off again. Then he would come out with the kodak on the ground. Finally, to expedite matters a little, I grabbed the kodak and led the pilgrimage through the hot sun that fairly roasted us as it beamed down and reflected sizzlingly from the dusty tracks along which we were walking.

At the entrance to the warehouse an old bewhiskered gentleman wearing a policeman's club demanded our passes. Here was a chance to exhibit prideful possession of new water-front passes. Now, there are passes and passes. Ours were issued at Cleveland and they were supposed to be good at any water-front of the United States. It said so plainly on the front of the little cards we handed the guard. Other embellishments consisted of our photographs, pasted on the face of the pass, with very interesting and useful information concerning the land of our nativity, our present whereabouts, our domestic state, and many other things. All of these intimate details appeared unimpressive to the guard.

As we flashed the cards into the old gentleman's view, it became evident that they were new ones on him. After the first squint, off came his spectacles, to be polished with the most aged and worn bandana I had ever seen. Then he caught sight of the pictures. He pulled his long white chin whiskers and tried to reconcile the photo with my moist and exasperated countenance; the sun grew warmer and warmer.

"Now see here young man," punctuating his remarks with swishing expectorations of Navy plug, "this here card's . . . no good to me. If'n you fellers expect. . . get in here. . . got to go to the office. . . get passes. Do you see? Passes is what you got to have. . . get in here. Yes sir, that's what you lads need if . . . want to get on the Juniata."

So we had to convince the old fossil that those pretty picture cards were passes. Our tempers were pretty far gone when he finally let us enter the warehouse, pointing out the hole in the door through which we could get to the steamer.

We hastened across the long building, winding our way among piles of flour that rose to the ceiling, stacks of bright copper ingots, bales of binder twine in sufficient quantity to tie up the universe, and huge packing cases in an innumerable number. Most of them looked fully as heavy as Snell's suitcase, and at least one—a case for a grand piano—faintly resembled my own outfit.

Arrived at the opening in the door he stopped to draw breath before going through to the river. Then we gathered up the luggage once more, for the last time, we firmly resolved. I took the mandolin and my traveling bag and Watson carried the rest of the paraphernalia. We pulled ourselves through the hole and saw—not the Juniata firmly tied up to the dock, but gracefully moving out in midstream on her way to the passenger docks. We were too late!

It was too much for overweighted nerves. Watchman, warehouse, Seeandbee, luck in general, individually and collectively, were made the recipients of the best of our American vocabulary. My grievances were expressed on general principles; Snell's because he knew it was a full half-mile from the warehouse slip to the Lackawanna pier where the Juniata would stop to take on passengers. This meant a half mile walk in the sun, back over those hot and dusty tracks—and a half mile more, after we had arrived at our starting place. I, of course, didn't know these details.

We sat down on a stevedore's truck and said various things about the weather and affiliated factors. Youth, however, is invincible; the funny side of it all soon became apparent. Laughter refreshed our minds. We knew that we were up against it, and it was best to be happy; to think of the good dinner we were soon to get.

It was then ten o'clock; by ten-thirty we had tramped back to the bridge over which we had just traversed; our passes had been viséd several times all over again. The walk was one to be remembered but not discussed.

You can easily see that we were about the happiest youngsters that ever boarded ship when we walked the gangplank of the Juniata that second day of July and started up the long and circuitous path that led to the radio room.

Our happiness was short lived, however. Scarcely had we crossed the plank when we were stopped by a man, tall and lean, complacently picking his teeth as though he had just had a full dinner. It was the captain. Introducing ourselves with our neat and well written letters from the Superintendent of the Marconi Company we asked the skipper if he had anything in particular for us to do beside getting ourselves acquainted with the radio equipment. Captain Jones was new at running ships with wireless attached to them, so he merely grunted, waved his hand and said he would see us again. He did . . . lots!

We disappeared up the companionway toward the radio cabin. Snell led the way, announcing that since he had been on board the Juniata for several months the previous summer, he was on to the curves of the ship. He disappeared with a rush up the steps, but those three narrow and steep flights, seemed like fourteen to me. By the time I had dragged my traveling bag and the kodak up to the aft saloon deck, I was nearly ready to fall over the rail.

But our troubles had barely started!

The equipment had been installed a few days before by the Marconi construction man, and it was our manifest duty to see that the stuff worked before the ship left port.

The first thing we noticed was the new paint. It was on everything, table, walls . . . apparatus, daubed on in generous fashion. It was not dry, and the plentiful supply on our coats required first attention. Snell was rather precipitous. He had sat down in the disconsolate looking chair that stared bravely through its new paints at us. Gracefully, and most confidently, he leaned back, all unconscious that he had wiped off half the white paint on his coat. Then he duplicated the result by putting his arms on the operating table in the same manner that we later found Bill—the second mate—eating. Friend Snell's disposition was not thereby improved.

I sat down, carefully, and with due respect for the fresh whiteness, hardly expecting to escape entirely. I pressed the key; the transmitter uttered a roar that brought me hard up against the wall—and more paint. But it was definitely established that the sender worked, and judging from the noise, we decided that it worked to perfection. But when we put on the receivers there was "nobody t' hum", as the Third Engineer might have remarked. We jiggled and juggled, changed all sorts of adjustments and traced wires, but still nothing but silence rewarded us. The navy station at Buffalo was in sight; so were several steamers, but not a scratch came into the receivers. Until a signal should be caught there was not the slightest excuse to leave for town and dinner. After two hours of alternate listening and adjusting we decided that something was wrong with the outfit.

"Maybe it's the phones," said Snell.

So I dumped the luggage out of my grip and dug up my head receivers. Watson tried them, held up his hand as if to say, "Sh, there's something doing." But it was a false alarm; in a few minutes his expression changed; by his face I knew the somebody had not as yet returned home.

It was then nearly noon, and still not a buzz had been heard. The trouble was clearly in the tuner, but one look into the maze of wires dismayed us. We turned to the connections, the explanations of which required dumping my stuff on the deck, in full view of the admiring members of the crew, so we could find a book containing circuit diagrams. This helped us to understand the puzzle and at twelve-thirty we were satisfied that everything was all right with the tuner circuit. Finally, we carted the whole works up to the top deck in an endeavor to get a good ground connection to the copper indicators. Still nothing doing.

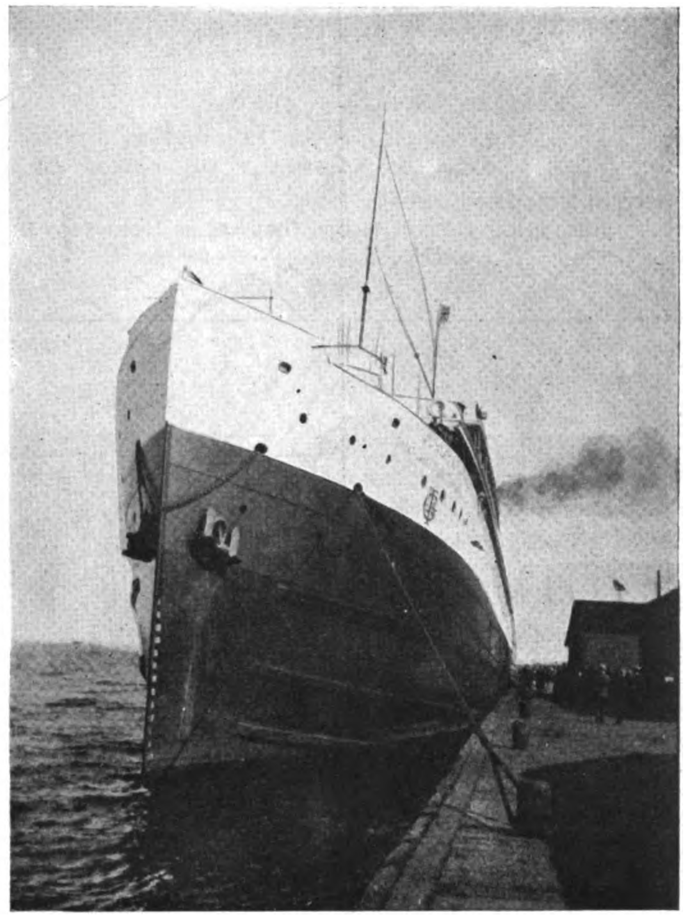
Fragmentary advice, muttered sections of virile vocabulary repeated in toto, spurred on by pangs of hunger and desperation, floated off the aft deck into the thick waters of Buffalo, but nary a splash of signals echoed in the receivers. About noon—that, is about one o'clock Buffalo time—the chef called us to the Officers' Mess and placed before us a couple of egg sandwiches. He was a wonderful chef. After devouring his offering we felt decidedly better and renewed our quest of the unknown with added zest.

At two o'clock, when we were still searching for trouble, several tugs puffed past towing the Tionesta—a sister ship of the Juniata—to the warehouse. As she was slowly maneuvered past us by the puffing tugs, I noticed the aerial wires came down to her deck in the same manner as our own, and as I thought of her equipment an idea came to mind. Why not exchange apparatus with the Tionesta? She was not due to sail for several days; the office would have plenty of time to get a new tuner to the vessel, and no one would be out. If worse came to worse, we would have a good outfit anyway and we could let the other operators worry.

As soon as the newly painted Tionesta was warped into her slip we hastened aboard. The construction man had taken the receivers with him, so we were compelled to disconnect the receiving cabinet and take it to our own ship to try it out. On the way back to the Juniata we had decided to merely exchange tuners and say nothing about it.

With the equipment tucked under our arms we ran for our steamer. It was then nearly three o'clock; we sailed at four. By a quarter after three everything was ready, wires connected again, receivers tested and batteries hooked up Snell sat in front of the outfit with a "Lord help us" expression on his face. Passengers were beginning to come aboard, and about everyone of them stopped at our cabin door on their way around the boat. The crew was below decks, much to our satisfaction. It was a tense moment. We would have to give up if the thing did not work at that late hour.

Fifteen minutes later the suspense ended. Strong signals were heard and we were at last free to sigh in relief and to take a look around us. It was then too late to go back to the Tionesta with the bum tuner, so we decided to carry them both until further orders.



The brightly shining copper wire of a new aerial on the vessel that was to be our home for the summer loomed up through the early morning mist and fog

At four we left for Cleveland on the first trip of the season, with a fair passenger list; at five we had a regular meal in the officers' mess, and at seven we sent our first message to the Marconi offices, announcing that we had "hooked" the Tionesta's tuner and that she had none at all. We fully expected to find two new operators at Cleveland waiting to take our jobs.

Without incident, the hours drew round to midnight when I came on duty fairly bristling with efficiency, after six hours of sleep. I looked about. The old box of a tuner lay in the corner of the cabin to which it had been relegated. The purloined one on the table registering every scratch of static and signal. Thoughtfully, I looked from one to the other, reflecting on the universal comment of passengers:

"What a wonderful thing wireless is. I simply don't see how it works!"

EXPERIMENTERS' WORLD

Views of readers on subjects and specific problems they would like to have discussed in this department will be appreciated by the Editor

Resonance in the Audio Frequency Circuits of Amateur Radio Transmitters

By John J. Holahan

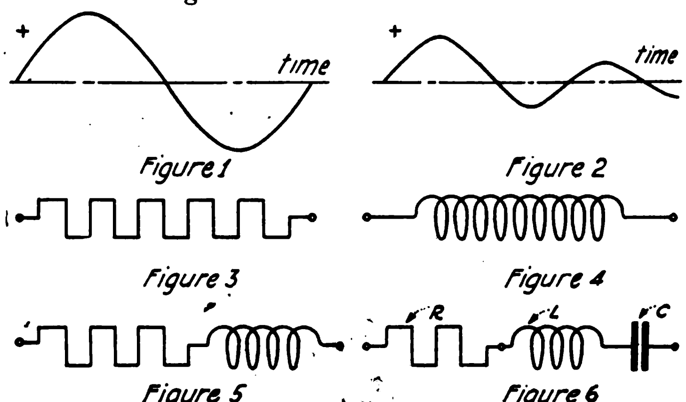
IN considering the effects of resonance in the audio frequency circuits of the radio transmitter, it is well to review briefly the theory of alternating currents. In direct current work the relations between electromotive force (volts), resistance (ohms), current (amperes) and power (watts); are given by the following formulae.

$$W = EI; \quad I = \frac{W}{E}; \quad E = \frac{W}{I}; \quad W = I^2 R;$$

$$E = IR; \quad R = \frac{E}{I}; \text{ and } I = \frac{E}{R}$$

In alternating current work these same general laws apply, in a modified form.

An alternating current is one that varies from zero to



Symbols used to represent alternating current, damped waves, resistance, inductance, and their combinations in series

maximum to zero in one direction; then reverses, rises to maximum, then falls back to zero. This is called one complete cycle, and takes a certain period of time, which can be represented by the graph, figure 1. This is a sine wave such as is sought after in general commercial work. It also represents the wave form of sustained wave transmitters.

A damped wave is one that reverses in direction but changes in amplitude. It is represented by figure 2.

The period of an alternating current is the time it takes the current to pass through one set of positive and negative values. Frequency is expressed in cycles per second. The period of the current is $f = \frac{1}{T}$, where T is the time of one cycle expressed in fractions of a second. Thus, the period of a 500 cycle current is 1/500 second.

The instantaneous value of an alternating current is the value of the current at any instant. The maximum value of such a current is the greatest instantaneous value during any cycle. The average value is equal to $I_a = \frac{2}{\pi} I$ max. The effective, or root mean square (RMS) value is the value usually spoken of in AC work, and is that indicated by AC ammeters and voltmeters. It is the square root of the mean of the squares of the instantaneous values of an AC current over a complete cycle.

The effective value $I_{eff} = \frac{I_{max}}{\sqrt{2}}$

As an illustration, if the effective primary voltage of a transformer is 110 volts, then the maximum value is $110 \times \sqrt{2} = 155.5$; the average value is $155.5 \times \frac{2}{\pi} =$ 99 volts. Effective values are used in this article.

All radio circuits contain resistance, inductance and capacity, connected up in various ways. Figure 3 indicates a simple resistance. In this case the current is represented by $I = E/R$.

Inductance is indicated by figure 4. It should be stated that any coil that has inductance has resistance also, but it is well to consider them separately, as they have different effects. The equivalent circuit is shown in figure 5. For this circuit the relations between E.M.F. current, resistance and inductance is given by

$$I = \frac{E}{\sqrt{R^2 + (\omega L)^2}} \qquad E = I\sqrt{R^2 + (\omega L)^2}$$

In the above $\omega = 2\pi f$, where f is the frequency in cycles per second. The factor ω is called the periodicity factor of the circuit. R is the resistance, E the voltage, I the current and L the inductance in henries. If this circuit could be made up to contain inductance only and no resistance, the relation would be,

$$I = \frac{E}{\omega L} \qquad E = I\omega L$$

The equivalent circuit for resistance, inductance, and capacity, in series is shown in figure 6.

In this case,

$$I = \frac{E}{\sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}}$$

$$\text{and } E = I \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$$

The term $\left(\omega L - \frac{1}{\omega C}\right)$ is called the reactance of the circuit. The term ωL is called the inductive reactance, and the term $\frac{1}{\omega C}$ is called the capacitive reactance. Inductive reactance is always positive, and capacitive reactance is always negative. Sometimes reactance is expressed by the letter X then,

$$I = \frac{E}{\sqrt{R^2 + X^2}} \qquad E = I\sqrt{R^2 + X^2}$$

The factor $\sqrt{R^2 + X^2}$ is called the impedance of the circuit. Resistance, reactance, and impedance are expressed in ohms.

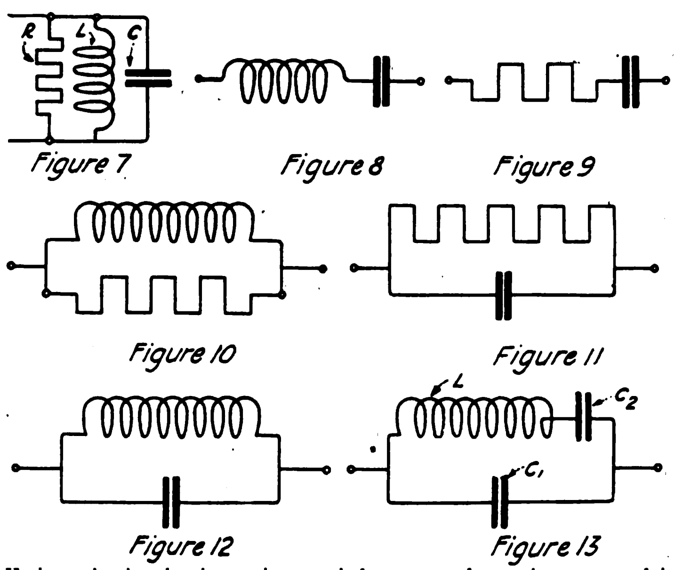
The reactance of a circuit may be positive or negative accordingly as ωL is greater or less than $\frac{1}{\omega C}$. When the reactance is positive ωL is greater than $\frac{1}{\omega C}$ and the current lags behind the E.M.F. in phase. When the reactance is negative $\frac{1}{\omega C}$ is greater than ωL and the current is ahead of the E.M.F. in phase.

The equivalent circuit for resistance, inductance, and capacity in parallel is shown in figure 7.

In this case,

$$I = E \sqrt{\left(\frac{1}{R}\right)^2 + \left(\omega C - \frac{1}{\omega L}\right)^2}$$

and



Various circuits showing resistance, inductance and capacity connected in series and parallel

$$E = \frac{I}{\sqrt{\left(\frac{1}{R}\right)^2 + \left(\omega C - \frac{1}{\omega L}\right)^2}}$$

For a circuit with capacity only,

$$I = E\,\omega C \text{ and } E = \frac{I}{\omega C}$$

An inductance and capacity in series are shown in figure 8. Then,

$$I = \frac{E}{\omega L - \frac{1}{\omega C}} \text{ and } E = I\left(\omega L - \frac{1}{\omega C}\right)$$

For a resistance and a capacity in series as in figure 9.

$$I = \frac{E}{\sqrt{R^2 + \left(\frac{1}{\omega C}\right)^2}}$$

also

$$E = I \sqrt{R^2 + \left(\frac{1}{\omega C}\right)^2}$$

For a resistance and inductance, in parallel as in figure 10,

$$I = E \sqrt{\left(\frac{1}{R}\right)^2 + \left(\frac{1}{\omega L}\right)^2}$$

also

$$E = \frac{I}{\sqrt{\left(\frac{1}{R}\right)^2 + \left(\frac{1}{\omega L}\right)^2}}$$

For a resistance and capacity, in parallel as in figure 11.

$$I = E \sqrt{(\omega C)^2 + \left(\frac{1}{R}\right)^2}$$

also

$$E = \frac{I}{\sqrt{(\omega C)^2 + \left(\frac{1}{R}\right)^2}}$$

For an inductance and capacity in parallel as in figure 12,

$$I = E\left(\omega C - \frac{1}{\omega L}\right)$$

also

$$E = \frac{I}{\omega C - \frac{1}{\omega L}}$$

Figure 13 indicates an inductance and capacity in series, shunted by a capacity in parallel. This is a "dummy" antenna of negligible resistance for which

$$X = \frac{\omega^2 L C - 1}{\omega C_2 + \omega C_1 \; (1 - \omega^2 L C_2)}$$

also

$$I = \frac{E}{X} \text{ and } E = I X$$

Resonance

In a radio circuit, containing a resistance, an inductance and a capacity, in series, which is the usual radio circuit, we have seen that,

$$I = \frac{E}{\sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}}$$

Now if we select such values of L and C so that

$$\omega L = \frac{1}{\omega C}. \text{ Then } \omega L - \frac{1}{\omega C} = 0$$

and

$$I = \frac{E}{\sqrt{R^2 + 0^2}}$$

$$I = \frac{E}{R}$$

The current is then limited solely by the resistance.

To explain this more fully, let us take the case of a simple valve which is shown in cross section in figure 14-A. The frictional resistance of the opening represents the resistance of the circuit, i. e., ohms. The pressure on the water corresponds to the E.M.F. of the circuit, and the amount of water that will flow to amperes. Now, if ωL predominates as in figure 14-B, then the opening is smaller and the resistance is higher. If $\frac{1}{\omega C}$ predominates, then we have the condition of figure 14-C; the opening is small and the resistance is still high. But, if $\omega L = \frac{1}{\omega C}$ the openings in the body and spindle of

the valve coincide and the amount of water that will then flow is determined solely by the pressure and the frictional resistance of the opening in the pipe.

Critical Frequency

This arises from the condition of resonance. If the resistance of the circuit is constant and we adjust L or C

so that $\omega L - \frac{1}{\omega C} = 0$

then, $\omega L = \frac{1}{\omega C}$ or $\omega^2 = \frac{1}{LC}$ or $\omega = \frac{1}{\sqrt{LC}}$

and since $\omega = 2\pi f$

then $f_c = \frac{1}{2\pi\sqrt{LC}}$

This is true for the usual radio circuit where the value of R is very small. The formula that takes in the value of the resistance R is

$$f = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{R^2}{4L^2}}$$

If R is small, then $\frac{R}{4L}$ reduces practically to zero and

the formula becomes $f = \frac{1}{2\pi\sqrt{LC}}$

It can be shown that for high efficiency in radio sets. that the natural frequency of the transformer secondary and the condenser should be the same as that of the generator. That is, the leakage reactance of the secondary should equal the capacitive reactance of the condenser. The leakage reactance of the secondary can be transferred back to the primary by dividing it by the square of the ratio of transformation. This primary reactance is made up of the leakage reactance of the transformer, the leakage reactance of the generator, and the reactance of the regulating reactance coil if any.

Take as an example, a 1 kw. 500-cycle transformer with a 220-volt primary and an 11,300-volt secondary shunted by 0.008 mfd. condenser; suppose the primary current is 10 amperes; the voltage on condenser,

$$V_{max} = 1000\sqrt{\frac{2 \times W}{\text{spark rate} \times \text{mfd.}}}$$

$$= 1000\sqrt{\frac{2 \times 1000}{1000 \times 0.008}} = 16{,}000 \text{ volts}$$

and $V_{eff} = \frac{V_{max}}{\sqrt{2}} = \frac{16{,}000}{1.4} = 11{,}300$

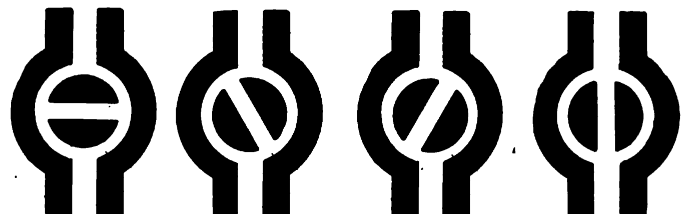
From the relation $\omega L_2 = \frac{1}{\omega C}$, L_2 should equal $\frac{1}{\omega^2 C}$ when L_2 = leakage reactance referred to the sec.

Operating 12 per cent off resonance for a good spark tone $= 500 - (500 \times .12) = 440$ cycles

$$\frac{1}{\omega^2 C} = \frac{1 \times 10^6}{4\pi^2 \times 440^2 \times .008} = 16.5 \text{ henries}$$

Secondary leakage reactance $= 2\pi \times 500 \times 16.5 = 52{,}800$ ohms.

When the gap is in action and the transformer secondary is practically on short circuit, the current in the secondary $\frac{\text{Sec V}}{\omega L} = \frac{11{,}300}{51{,}800} = 0.218$ ampere.



a b *Figure 14* c d

Cross section of a simple valve used to illustrate the relation of resistance, inductance and capacity

When the secondary is charging the condenser with the gap not discharging $I = \omega C E = 2\pi \times 500 \times 0.008 \times 10^{-6} \times 11{,}300 = 0.283$ ampere. For working conditions, take the average of these two or 0.25 ampere. This is an approximation.

The ratio of transformation for the conditions outlined above

$$= \frac{\text{Pri I}}{\text{Sec I}} = \frac{10 \text{ amp.}}{0.25 \text{ amp.}} = 40 -$$

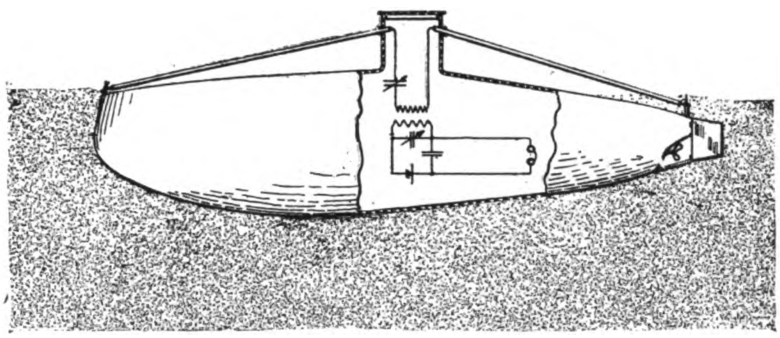
Ratio squared $= 40 \times 40 = 1600$ and the total primary inductance $= \frac{16.5}{1{,}600} = 0.01$ henry. The total primary reactance must equal $2\pi \times 500 \times 0.01 = 31.4$ ohms.

This must be made up of the leakage reactance of the primary, the leakage reactance of the generator, and the reactance of the primary choke.

Methods of finding the leakage reactance of generators will be given in a paper on 500-cycle generator design.

Roger's Underground Aerials

THE Roger's wireless telegraph aerial for submarines is a closed circuit loop with a transmitting or receiving apparatus coupled at the middle as shown in the diagram figure 1. The antenna wires 11 are thoroughly insulated from the structure of the vessel except at the points 12 and 13 where a connection is made to the hull. An inductance connected in the middle of the antenna transfers the incoming signal to the detector circuit and the variable condenser 23 is employed as a tuning element. The same antenna is used for transmitting purposes, the primary of the oscillation transformer of the transmitting set being coupled inductively to the coil 16.



Method of installing the Roger's system aboard a submarine

Several forms of the Roger's underground aerial have been described in a recent U. S. patent. Figure 2 shows where the underground conductor extends horizontally or substantially parallel to the earth's surface. This aerial is enclosed with a metallic covering, casing or screen 21 which may be a tube of lead pipe, iron or any other suitable material. The antenna is insulated from the metallic covering by means of the insulation 12; that is, although the antenna is buried in the earth it is completely insulated therefrom and from the metallic covering or casing.

The diagram of figure 2 shows a receiving apparatus inductively coupled to one end of the aerial, the other end (of the aerial) being ground to earth through the plate 25. A conventional type of transmitting apparatus, indicated to the right of the drawing, may also be coupled to the coil 24 for transmitting purposes.

In the modification shown in figure 3, the ground connection is replaced by a second antenna 20' which extends in the opposite direction to the antenna 20. The signal instruments are located between the antenna and are coupled thereto by the usual inductive coupling. The signaling instruments are encased in a metallic chamber 26.

Figure 4 shows structure similar to figure 3 with the exception that the aerials lie on the surface of the ground. In figure 5, the antenna is elevated slightly above the surface of the earth being supported on struts or pins 28. The metallic covering in this case is not in direct contact with the earth. The covering may or may not be insulated from the earth.

Figure 6 shows two antennae of the Roger's type submerged beneath the water and figure 7 shows the employment of ground connection 30 at the outer end of the antennae.

The inventor remarks that careful tests and experiments have shown that by the employment of sectional metallic casing in intimate contact with the earth, but insulated from the radio conductor or antenna—the sections of the casing being insulated from each other and connected by couplings of insulating material—very much longer antennae may be employed than is possible with the continuous metallic casing. He also states that this construction reduces the interference of static.

Careful scrutiny of these diagrams leads us to believe that these underground aerials function like the closed circuit loops in the Weagant system, experiments on which were begun several years ago.

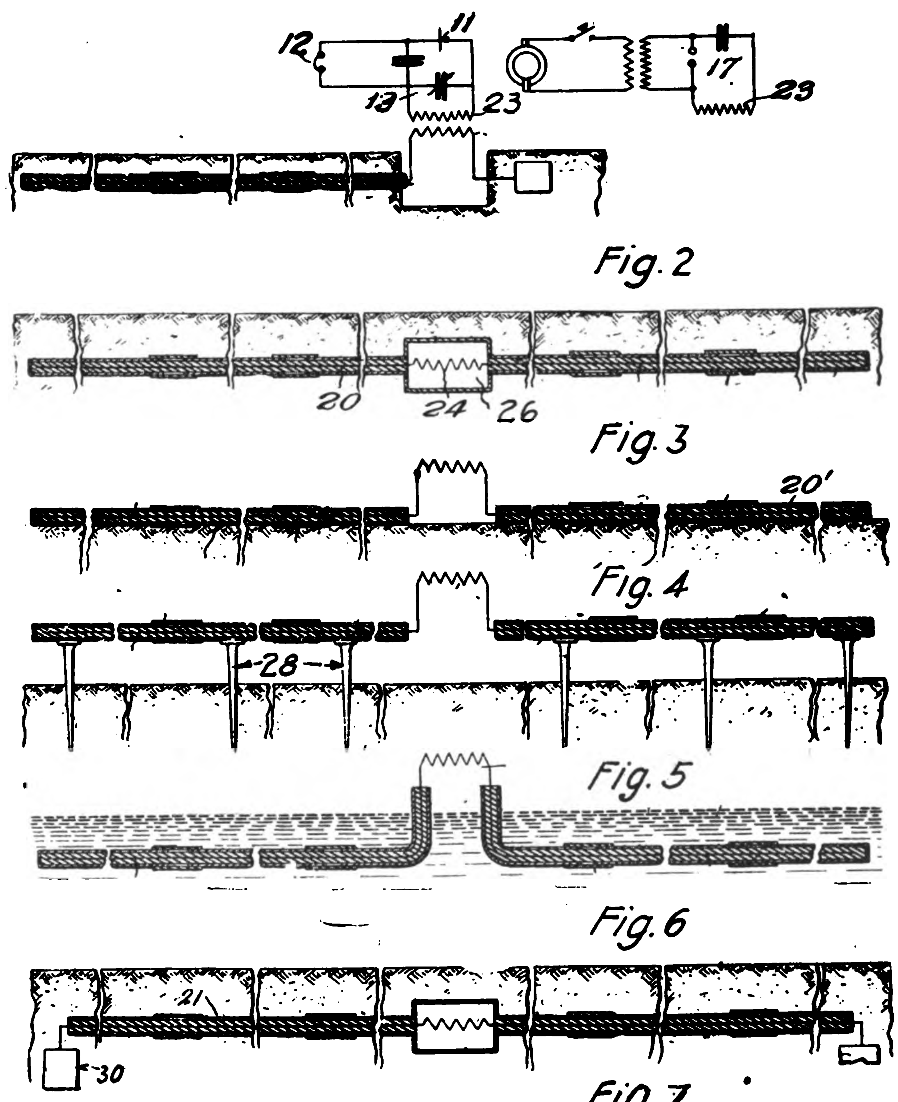


Diagram showing various arrangements of the aerials

Panel Transmitter

SEVERAL well designed transmitters have been described in this magazine but I have failed to see any that compared, in compactness, short leads and simplicity, with the transmitter shown in the accompanying drawings. It is designed for those who desire a compact and efficient transmitter instead of a cumbersome and complicated one.

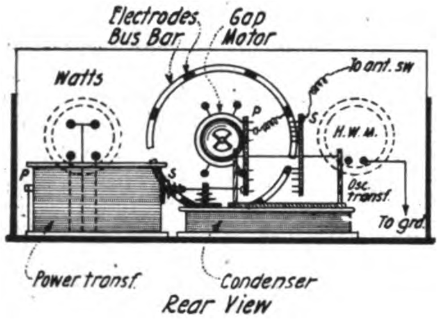


Figure 1.—Showing rear view of the panel transmitter

The panel is a marble slab 30" x 18" x 1½". Bakelite or some such material, however, is better since it is hard to obtain marble free from metal veins which would cause serious losses. It is supported by a baseboard 30" x 20" x 1" and is supported by brackets at each end. On the face of the panel is mounted a hot wire ammeter on the left, a Vernier type rotary gap in the center and a wattmeter on the right as shown.

The rotary gap has 12 stationary electrodes (only 8 are shown) in a 12" circle. A light rotating arm 10" long is mounted on the motor shaft and insulated therefrom. The 1/20 H.P., 6000 R.P.M. series wound motor is securely mounted on the rear of the panel, the shaft protruding through a ½" hole. Any fan motor will answer the purpose. A small rheostat mounted on the operating table, is hooked in series to vary its speed. The gap is quick to start and stop and produces a high musical note. It runs with less vibration than if a heavy disc was being propelled. It may be started and stopped by connecting to the antenna switch as shown in figure 4.

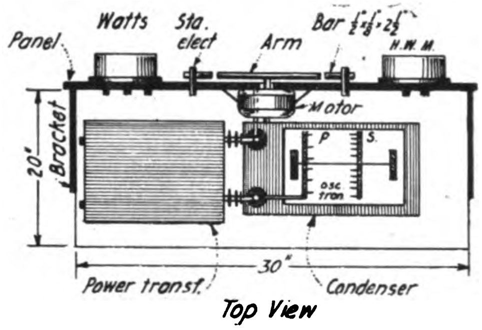


Figure 2.—Top view showing the position of the various instruments

The stationary electrodes are connected in the rear by heavy bus-bar cut in two semi-circles, 6 electrodes on each half as shown. A bar ½" x ⅛" is used for electrodes.

The transformer is a 1 kw. open core with a variable reactance coil mounted in a case, allowing close variation of power. However, any well designed transformer will do.

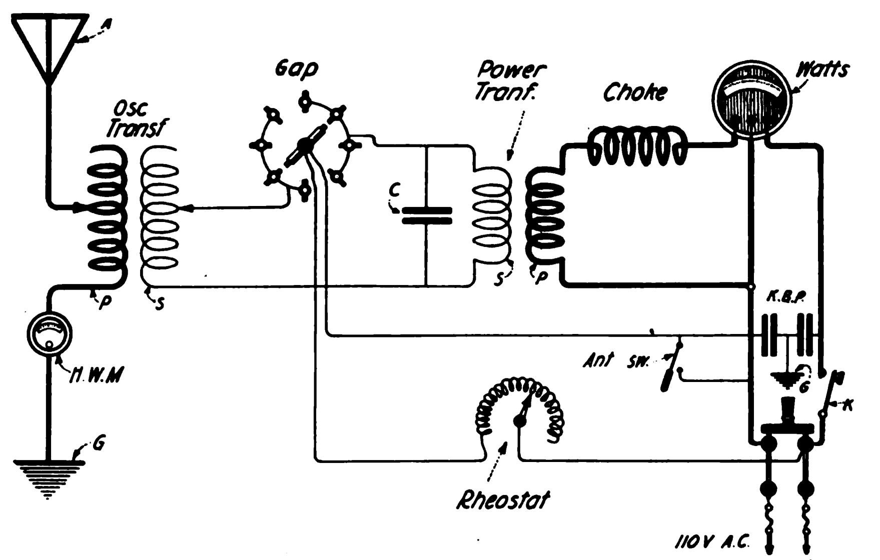


Figure 4.—Diagram of circuit used

The condenser is a glass plate, oil immersed type. Four banks of four plates each are connected in series parallel to reduce the strain on the plates. Its capacity should be about 0.008 mfd. for 200 meter wave. It is mounted so that the terminals will meet the transformer terminals which may be changed to make a short lead.

The oscillation transformer is placed on the condenser case as shown. Its base and uprights are hard wood with bakelite supports for the copper ribbon. The primary which may be stationary, has 5 turns of heavy ribbon. The secondary which slides on an insulating bar has 9 turns. In both cases the turns are spaced ¾" apart. The pancake type has proven more efficient than the "bird-cage" type. The connector used to vary the inductance is soldered to heavy flexible ribbon or wire. It is provided with a set screw so it may be secured well after tuning. One is sufficient for each inductance. Fixed values are not advised because changes in various things will require constant changes of inductance.

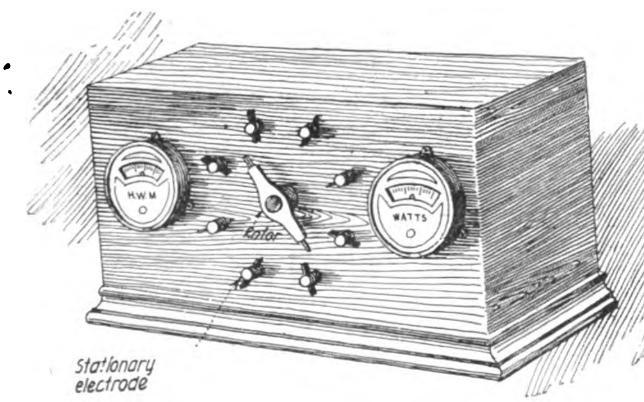


Figure 3.—Front view of panel with instruments inclosed

All low tension wiring is lead covered and the lead grounded. It should be run at right angles to high tension leads and as far away as possible.

Condensers are shown as protective devices, but the writer would advise a high resistance carbon rod placed across the line and grounded in the middle as condensers break down easily.

A switch may be used to cut the H.W.M. out of the circuit, but switches in the high tension circuits are sure to cause trouble and losses of energy.

If a little care is taken in placing the various instruments very short leads will result. A short ground lead and longer antenna lead is preferable than the reverse. Use of a magnetically controlled antenna switch and a relay key, allows remote control.

HERBERT M. WALLEZE—*U. S. N.*

The Marconi V. T.—A Three-Electrode Oscillation Detector of Approved Operating Characteristics

AMATEUR experimenters who have been accustomed to use the audion detector will greet with pleasure the announcement that the Marconi Company is now able to supply three electrode tubes for experimental purposes in any quantities. Several types of vacuum tube detectors were developed for specialized services during the war, but realizing that a good majority of the amateurs are not in position to purchase a family of vacuum valves, the Marconi Company has provided an all-around detector of uniform operating characteristics which may be said to represent an average of the good points of all vacuum tubes.

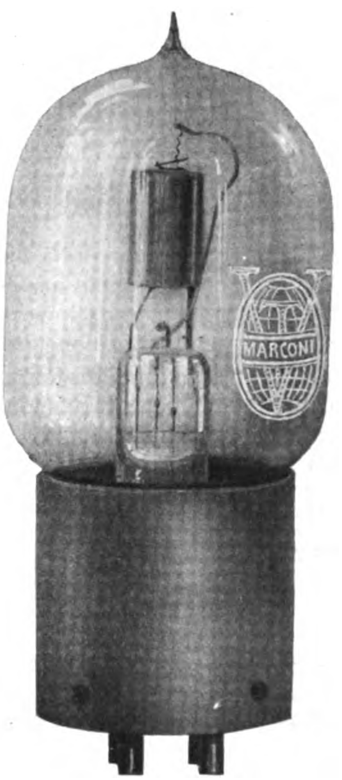


Figure 1.—The Marconi V.T. Oscillation detector

A point that will make special appeal to the experimenter is that the Marconi V. T.'s are standardized. This insures to all purchasers a uniform degree of sensitiveness and does away with one of the chief objections put forth by former buyers of vacuum tubes.

The Marconi V. T. is built to take the standard 4-contact base which makes all connections to the grid, filament and plate when the bulb is inserted. The tube has the usual grid, plate and filament. The filament operates off a four-volt storage battery without a rheostat. If a 6 volt storage battery is employed, a 10 ohm variable rheostat should be connected in the filament circuit. The filament current is approximately .7 ampere. The plate voltage for reception lies between 20 and 60 volts. In the amplification circuit shown in figure 3, the plate E.M.F. should be 80 volts.

The D. C. characteristics of the tube for various plate potentials up to 375 volts are shown in figure 4 and indicate uniformity. Figure 5 shows the curve of voltage amplification which compares favorably with other types of detector bulbs.

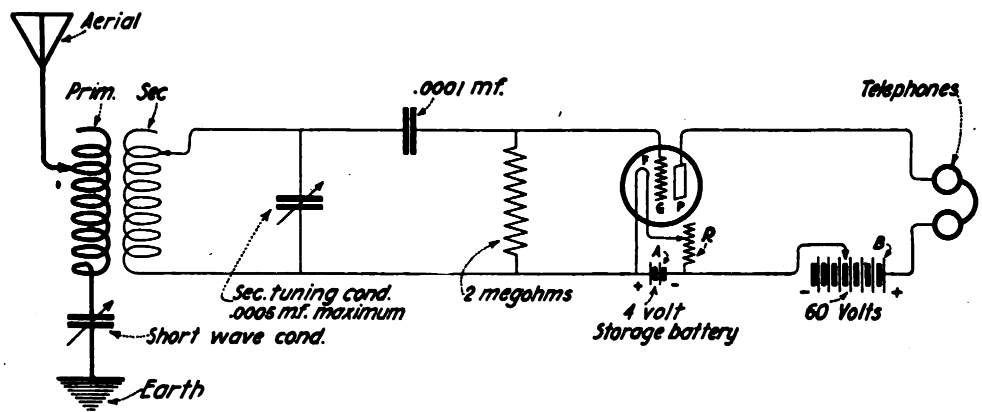


Figure 2.—The best detection circuit for the Marconi V.T.

The preferred detection circuit in figure 2 shows the usual inductively coupled receiving tuner, the secondary coil of which is shunted by a variable condenser of say .0005 mfd. maximum capacity, although for the shorter range of wave lengths, this condenser may be dispensed with. The grid condenser may be fixed or variable. Its capacity should be approximately .0001 mfd. A grid leak of 2 million ohms is connected between the grid and filament in order to provide maximum ratification. The leak prevents the piling up of high negative potentials on the grid which otherwise would render the tube inoperative.

Although these leaks can be made by drawing lead pencil lines between two binding posts on cardboard, the Marconi Company has provided standardized leaks of 2 million ohms mounted on a base ready for use. This saves the user a good deal of experimenting, for unless he possesses a bridge for making resistance measurements he would have some difficulty in securing the required resistance.

For amateur experimenters who desire to work their 200 meter sets over great distances, the circuit for the cascade amplifier in figure 3 has been provided. It is believed that once the experimenter has an opportunity to observe the amplification which this circuit makes possible, he will employ none other. It is to be noted that the plate circuit of the first tube is coupled to the grid circuit of the second tube throught the choke L3; and that the plate circuit of the second tube is coupled to the grid circuit of the third tube through a resistance R-1 of 2 million ohms. The leak resistances R have resistance of 2 million ohms each.

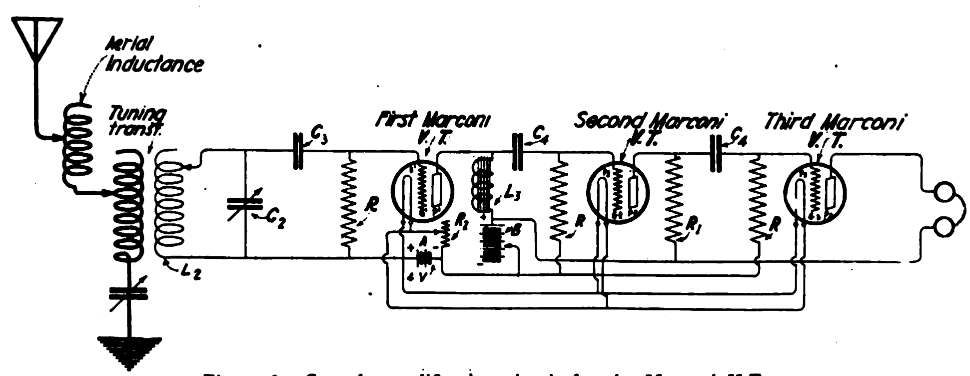


Figure 3.—Cascade amplification circuit for the Marconi V.T.

A particular feature of this circuit is the use of a single battery for the filaments and another battery for the plate circuits of all tubes. The current consumption of the three filaments in parallel is approximately 2.2 amperes. The plate battery—commonly known as the "B" battery—should, in this circuit, have a potential of 80 volts for maximum amplification. The choke L-3 has an inductance of approxi-

mately 20 henries. It can be made by winding 10,000 turns of No. 36 enamel wire on a core of silicon steel or iron wire ⅝" in diameter and 3" long. Condensers C-4 should have a capacity of .005 mfd. each.

by putting 60 volts on the plate circuit and then carefully adjusting the rheostat until loud signals are obtained for distant stations. Other values of plate voltage should then be tried and different filament temperatures keep-

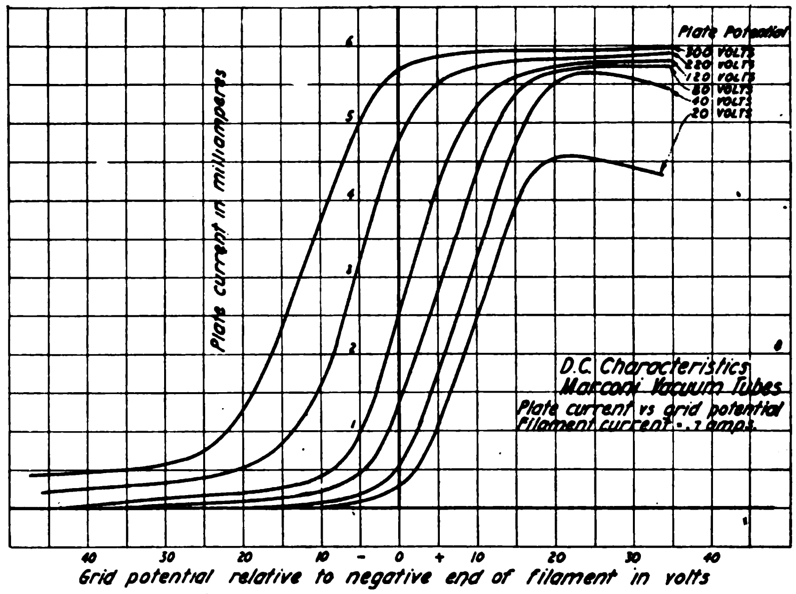


Figure 4.—The D. C. characteristics of the tube for various plate potentials indicate uniformity

There are certain precautions which the operator should take in the operation of this tube. It should be noted that its operating life is approximately 1500 hours and this means that if the amateur uses the tube four hours per day, its life will extend over a period of one year. By careful use of this tube, still longer life may be expected.

If the potential of the filament bat-

ing the filament current well within the limits.

The filament should not be burned at higher temperatures than are necessary for strong signals as lower temperatures will tend to prolong its life.

If a battery in excess of four volts is used for the filament, care should be taken to cut in all the resistance at the rheostat immediately after the valve is

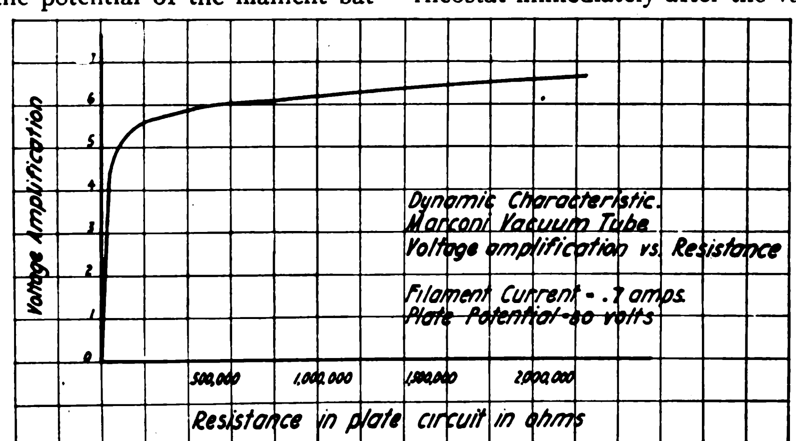


Figure 5.—The curve of voltage amplification

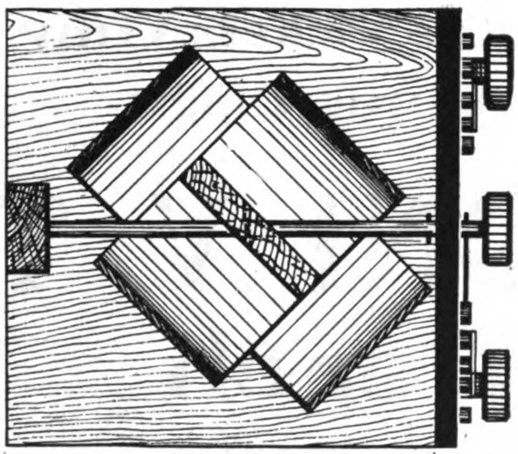
tery exceeds four volts, care should be taken not to exceed the stated filament current of .7 ampere.

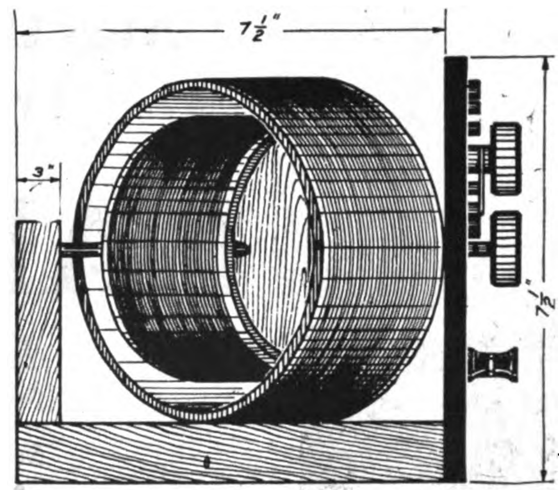
The required filament temperature can be obtained without an ammeter

put out of service, for otherwise the storage battery may recuperate sufficiently, while standing idle, to burn out the filament the next time the filament circuit is closed.

A Receiving Transformer for Arlington Time Signals

THE receiving transformer shown in the accompanying drawings is suitable for the reception of wave lengths up to 3,000 meters when used with the average amateur antenna. The unusual feature of this transformer is the method of mounting the primary and secondary coils. Each coil is mounted at a 45 degree angle with the shaft. This permits the coupling to be varied through a 180 degree scale, and allows room for the shaft to pass through without interfering with the windings.


Top plan view of the receiving transformer showing primary and secondary coils mounted at a 45 degree angle with relation to shaft



Side elevation and dimensions of construction

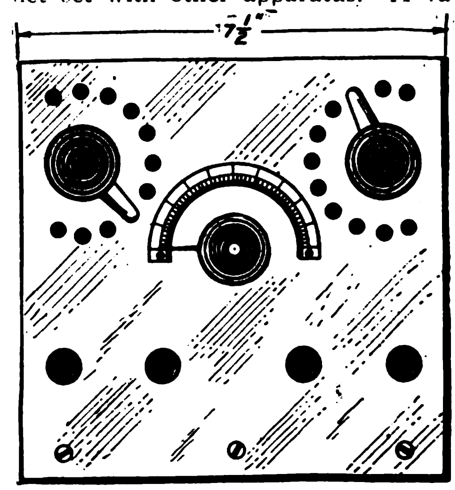
The primary inductances consists of 200 turns of No. 28 S.S.C. wire wound on a shellaced paper tube 6" outside diameter, 3¼" long, 3/16" thick. Eleven equally spaced taps are brought out and connected to one of the 11-point switches on the hard rubber panel. The tube is clamped to the base with a metal strip held down at each end with a wood screw. The inductance of this coil is approximately 6,000,000 centimeters.

The secondary inductance consists of 240 turns of No. 30 S.S.C. wire wound on a shellaced paper tube 4½" diameter, 3" long and 3/16" thick. Eleven equally spaced taps are brought from this coil to another 11-point switch, with extra flexible green silk covered telephone cord. These leads should pass through 11 holes drilled through the wood block which supports the tube, near the shaft, so as to reduce the strain on the connections. All connections must be soldered. The tube is mounted on the block before winding and held with 6 pins, three at each end. The inductance of this coil is approximately 6,000,000 centimeters, and when shunted by a capacity of .0005 mfd. will respond to a wave of 3,250 meters.

The shaft is of hard wood ¼" in diameter by 8½" long. It passes through the secondary coil support at a 45 degree angle and is held by a wooden pin glued in place. The knob is turned from ½" hard rubber and pinned to the shaft.

The base is of hard wood 1" thick. The panel is fastened to the base with 3 wood screws as shown. Four hard rubber binding posts are mounted on the panel, two for the secondary and two for the primary.

This scheme of coupling may be used with any size of tuner, and can easily be mounted on a panel or cabinet set with other apparatus. A variometer connected in series with the primary will be useful when close tuning is desirable. The coupler can be used with an ordinary crystal detector, but is intended primarily for audion work.

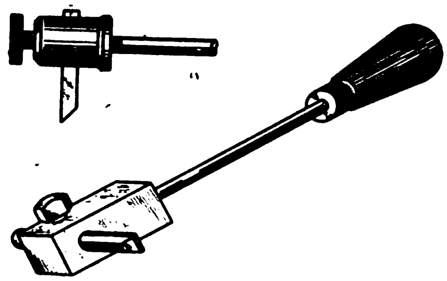


Panel board with switches and binding posts mounted

Clyde J. Fitch—*Massachusetts.*

Soldering Copper for Delicate Work

FINE apparatus and instrument work involves a considerable amount of delicate soldering work which, like many other things, is best done with properly designed tools. The soldering copper shown in the accompanying sketch will help wonderfully in many of those particular and hard-to-get at jobs. A large binding post and a bit of brass rod will suffice when improvising for a short job but the usefulness of the more permanent type well warrants its construction. In either case the body should contain sufficient mass to store a considerable amount of heat. The right angle feature provides a comfortable working posture and does not obscure the work from view while soldering. It also permits the heating of the tool on a gas range without oxidizing the tip by allowing only the body to come in contact with the flame,



Improved soldering tool for delicate work

which means in other words, less filing and retinning. In work on fine wires, the tip will work nicely with extensions up to one inch.

C. H. Biron—*Massachusetts.*

Contest Winners for August

The June Wireless Age subject for discussion was: "What are the relative merits of the regenerative vacuum tube receiver and the cascade vacuum tube amplifier for radio reception at amateur wave length?"

First Prize—The Regenerative Receiver and the Cascade Amplifier for Amateurs

IN pre-war amateur stations, the cascade amplifier was usually regarded as an expensive luxury, because of the necessity of a separate battery for each bulb, and the multiplicity of other equipment required. In addition, it was difficult to adjust readily, and because of these defects it found only a limited application, being more of a novelty than a utility.

At the hands of modern research engineers, however, an improved type of vacuum tube was evolved, which does away with the critical adjustment required by the old type of tube and makes the cascade amplifier a practical device. Tubes similar to this are now being placed on the market for the amateur experimenter, and through their use, we may expect the cascade amplifier to become common in all of the more advanced amateur stations, taking the position formerly held by the regenerative receiver.

The most common regenerative circuits in use at the present time are of the following types: The variometer type, as used in a popular amateur receiver; the tickler coil regenerative, largely used by the U. S. Navy; the condenser regenerative; and the single coil, direct-connected type, used in the Simon airplane receiver. There is still another type which was described in the june Wireless Age by Mr. M. W. Sterns. These are all fairly simple, requiring a minimum of apparatus, a single vacuum tube, and only one set of batteries. Since the upkeep cost of the batteries required for a cascade receiver is considerable, there is no doubt but that the regenerative set will always remain popular among amateurs of limited means. Another point in its favor is the simplicity of adjustment which is so essential when interference is bad, although, as I have already mentioned, the cascade amplifier in its perfected form is equally simple. The main points in favor of the regenerative receiver for amateur purposes, are: Low initial cost; greater simplicity of apparatus; and lower upkeep cost of batteries and tube renewals.

The cascade amplifier, on the other hand, is absolutely necessary for certain types of receiving work, as with the directional loop antennae, the use of which would be a long step forward in solving the interference problem. Also, the use of recently perfected static eliminators will make it possible to use a greater degree of amplification which should permit some remarkable receiving ranges.

The question of supplying battery current for a multi-stage amplifier is best met by using a medium-sized storage battery of perhaps 60 ampere

hours, and having a rectifier or charging machine at the station. With an efficient rectifier such as the Tungar or a small motor generator, such a battery can be charged once a week at a cost of about fifteen cents, whereas battery stations usually ask a dollar or more. The initial investment required will soon be repaid by the money thus saved.

The successive tubes in the cascade amplifier are coupled together by three different methods, by resistances, by impedances, or by transformers, any of which can be constructed by the amateur, or purchased at a moderate cost, so that the chief outlay will be for the tubes and battery equipment. Summing up these considerations, we find a large initial cost, larger upkeep cost, wider application for new receiving devices, and increased receiving range, which would seem to indicate that the cascade amplifier will be a necessity in the truly modern amateur station.

ARNO A. KLUGE—*California.*

Second Prize—Regenerative vs. Cascade Amplifier

THE regenerative audion circuit is popular for several reasons. Its low cost is the special inducement which attracts the radio amateur. The operating results are very satisfactory, amplifications as high as one hundred times being recorded. Only one tube which acts as detector and amplifier is needed, and there is only one high voltage and one low voltage battery to regulate. The number of adjustments in the secondary circuit are few, only three or four variable condensers being necessary. The regenerative circuit is almost equally effective in receiving undamped waves, thus adding to the utility of the set.

The cascade amplifier is a very fine instrument for boosting weak signals to audible ones. The principal objection to its use is the prohibitive first cost—an audion detector and several amplifier units being required. The cascade amplifier using one plate and one filament battery is just beginning to be recognized by the experimenter, and if he possesses the funds to buy a set of this kind, he will put it all over the fellow with a single bulb set.

In some cases each amplifying unit has a separate high and low voltage battery unit, and these are so closely related that an expert is needed to operate them. The amplifier is a very effective instrument; but for the average amateur it is a little beyond his reach. The regenerative circuit gives remarkable results with careful handling, and being simpler than the cascade amplifier it continues to grow in favor with the progressive radio amateur who is impressed with practical results.

R. C. HITCHCOCK—*Connecticut.*

Third Prize—This Experimenter Prefers the Regenerative Receiver

IT is claimed by one of the editors of a contemporary radio publication that the vacuum tube cascade amplifier is far superior to the regenerative valve for amateur work. The editor bases his claims on the matter of reliability, claiming that the regenerative set will work one minute and won't work the next; that, in some cases, it works very satisfactorily when the amateur has no traffic to handle, but when it is most needed, the bulb cannot be made to oscillate for the love of money.

It seems to me that the set to which the gentleman referred is quite typical of some of the amateur home-made regenerative sets, but I can assure him that if he has ever operated a regenerative set using the proper circuit he has a 100 per cent. fool-proof set.

If the amateur will choose a circuit which secures good amplification a good bit below the oscillating point of the bulb and if he fits his aerial change-over switch with contacts to break the "B" battery circuit while transmitting, and not the "A" circuit, he will always "come-back" from transmitting and find the bulb adjusted to almost perfect amplification. If the *filament circuit* is broken when sending—not the high voltage circuit—the "A" battery invariably picks up a bit and he finds the set completely out of adjustment when he switches over to receive. The reason for breaking the B circuit and not the A battery is that the B battery's "picking up" does not affect the operation of the bulb as much as the A battery does.

Another point in favor of the regenerative set is the matter of low cost, as compared to that of a 3-step amplifier. I will admit that the amplifier is more suitable for reception over a longer range of wave lengths than is the regenerative set, without changing as many adjustments, but as the amateur wave is pretty closely defined between 200 and 425 meters, it is a comparatively simple matter to adjust the plate inductance, be it a variometer or a tapped coil.

I doubt whether a 3-step amplifier and a detecting valve are as "fool-proof" in operation as some may believe unless a modern circuit using one filament and one plate battery is employed.

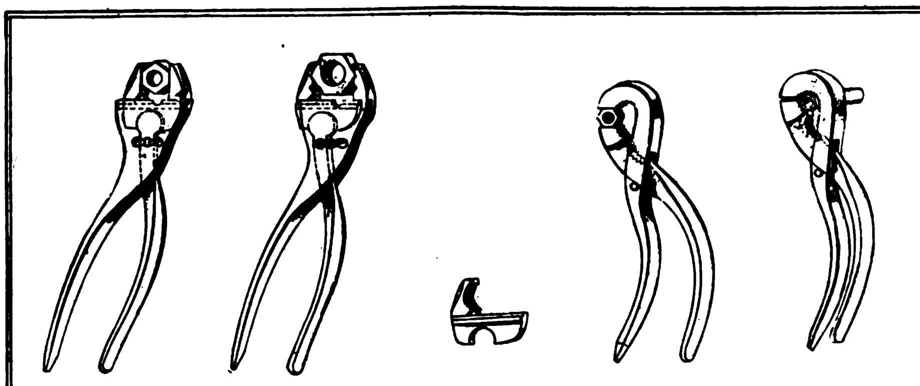
Don't you think that it is a little early to predict the use of undamped oscillating sending sets for amateurs? It certainly cannot be expected until some kind manufacturer comes out with a nice little high voltage DC motor generator set at a price somewhat in reason.

I have been wondering quite a bit lately whether we may not predict transoceanic amateur communication before so very long. There certainly must be at least one amateur in England who could help us out at that end of the line—as soon as the Britishers come out of their "ban-ishment"—and I know there are several amateurs in New York City who can most assuredly offer the best that can be had in amateur apparatus. Figure it up, and you will see that the air-line distance from New York to some city in England is not so terribly much greater than is the distance some of the U. S. "hams" covered in the long past season of 1917. In addition look at the great expanse of water we have to work over—practically all the way across. I've been thinking long and hard of this thing and want to see some of the "boys" up in New York City try it out. I feel sure before many seasons pass that it will be done. If you think it worth while trying, and to get the matter stirred up, I can give the names of two amateurs in England whom I know would be eager and willing to co-operate with our American friends in making tests.

JOHN M. CLAYTON—"5 *BV*."

Electrician's Pliers

A WESTERN inventor has brought out two types of plier wrenches that will fill a long-felt want in any mechanic's tool-kit. These wrenches are quick-acting, self-adjusting, always taking a firm grip on any object that may be clamped in the jaws. Their construction is simplicity itself.



Improved mechanic's pliers suitable for extensive use

The main feature claimed for the wrenches is that the jaws are always parallel when clamping objects of various sizes whether the jaws are closed or wide open. When clamping nuts, pipes or objects of various sizes, the grip of the handle is always the same.

In figure 1, the jaws are clamping a medium size nut while in figure 2 they are holding a large size nut and the jaws are nearly entirely open. It will be observed that the handles are in about the same position irrespective of the jaw opening.

Drawing No. 3 shows a pipe jaw that is interchangeable with the regular jaw used for nuts. This attachment proves very valuable for loosening nuts that have had the corners rounded off. The pliers may also be used as a pipe wrench.

In sketch No. 4 a special form of pliers are shown gripping a medium size nut. It is to be noted that the jaws are parallel, and that the handles are far enough apart to give good leverage. This plier wrench has no adjustments. It is semi-automatic and self-adjusting to any size, such as nuts or pipes that may be clamped in the jaw.

In drawing No. 5 the jaws are nearly closed and are gripping a small size pipe. Note that the jaws are parallel the same as they are in figure 4 gripping a medium size nut. An eight-inch pair of pliers will take a three-quarter inch pipe. Moreover, it has a parallel jaw opening that will take in any flat object such as a nut. As these plier wrenches have hook jaws and end openings they will appeal particularly to steam fitters, electricians, automobile owners and mechanics in general.

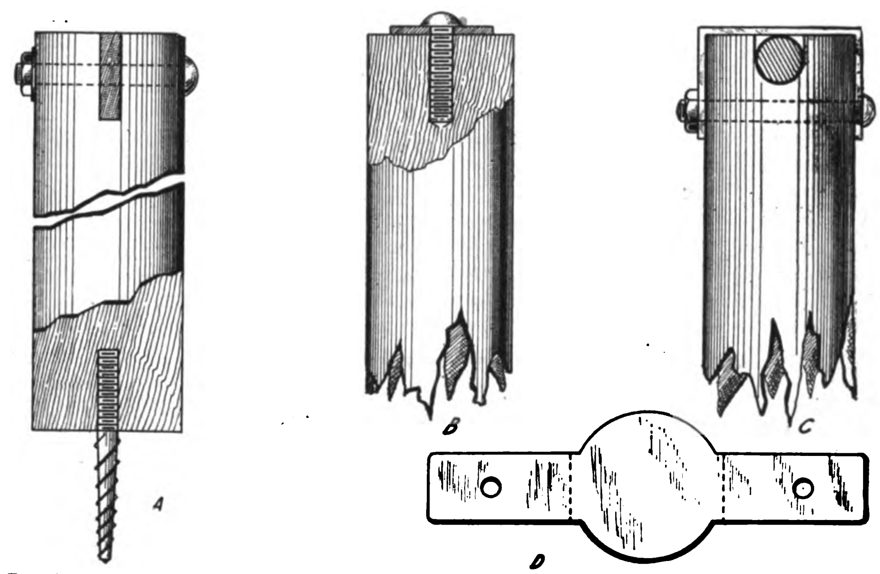
A. C. ALLEN—*Illinois*.

A Neat and Efficient Aerial Lead Support

IN carrying the aerial lead from the instruments to the point where it passes out of the operating room, it should be supported at intervals on neat insulated supports. Although several forms of electrose and porcelain pillars suitable for this purpose are on the market, a plain pillar of genuine hard rubber, bakelite, or even good hard fibre possesses all the desirable characteristics in the way of insulation, and further, it can be made to suit the exact requirements of the individual installation in which it is used.

The size of the rod used will vary according to the size of conductor to be run flat upon the supports, it can be secured by a machine screw passing through the strip into a threaded hole in the top end of the rod, as at B.

If the conductor be of circular cross-section as in the case of wire or tubing, then the method shown at C can be used. This consists of forming a groove in the top end of the rod of such a depth that the conductor comes flush with the top of the rod when it lays in the groove. It is held in position by a cap made of a piece of sheet brass with two ears (see figure D), that extend down on either side of the rod and is clamped by a 6-32 screw



Drawings showing various styles of improved lead supports and the method of construction

be carried, but ¾" diameter by 4" high will be found to possess the required mechanical strength and right proportion. There is nothing to be gained by using a much greater diameter rod than this and the expense mounts rapidly with increase in diameter; on the other hand, a smaller diameter is too weak mechanically, and gives the insulator an appearance of frailty. As depicted in the drawings, a wood screw of about No. 10 or No. 12 size and 1¾" long has its head sawed off and the smooth portion threaded with a 10-24 thread. The length of this machine thread will be about ¾". It is screwed into a hole drilled and tapped into the bottom of the pillar, leaving about 1" of wood screw thread protruding. If the conductor is flat strip or ribbon, and it is desired to support it on the pillars in an edgewise position, a slot can be sawed in the top of the rod for a depth equal to the width of strip and the same held in place by a machine screw passing through the rod and strip as at A. Where the strip is to passing through the same. If desired, a plain tie wire may be used in the place of the metal cap. However, this is not so good because all the sharp projections of the tie wire would be present. This should be avoided on a conductor carrying currents of high voltage and high frequency. Another and probably the simplest method that can be utilized, is to merely bore a hole through the rod to slip the conductor through, and after all the pillars are fastened in place the conductor is threaded through the holes in same. There are still other means of fastening, but they require the chasing of threads on a lathe which is not always available. When the pillars are mounted on brick walls a hole should be drilled in the wall with a star-drill and plugged with a soft wood plug to accommodate the wood-screw. If a lathe is handy, the pillars may be turned to a taper and a series of grooves may be cut on the surface of the rod. The only real requirement is that the ends be cut off square.

J. A. WEAVER—*Maryland.*

The Monthly Service Bulletin of the

National Wireless Association

Founded to promote the best interests of radio communication among wireless amateurs in America

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Radio Telegraphy vs. Telephony for Amateurs

MANY are looking forward to the time when amateur communications will be carried on by the wireless telephone instead of by the familiar wireless telegraphy. The writer is of the opinion that such a time will never be for the reasons that are given in this article.

Prior to the war the radio amateur station had reached a high state of efficiency. The entire country was threaded with the so-called "trunk lines" and the public was being well served in many localities. The short wave regenerative set was being perfected, and efficient 200 meter transmitters were a known quantity. Had not the war interfered a very high state of perfection would have been reached.

The war called many of us and gave us a taste of Government and commercial wireless operating. Many improvements were made. Vacuum valve circuits were brought down to perfection, the barrage receiver was invented, ground wires and loops came into use and static was substantially eliminated. The vacuum valve transmitter for wireless telephony has been improved to such an extent as to allow speech transmission for hundreds of miles.

The war is now over and the amateur is returning to his old line of work. Trunk lines will be carried to a point of perfection, the non-synchronous gap type of transmitter will be pushed to the limit, many amateurs will do serious work with the vacuum tube wireless telephone and some may cover distances of from 100 to 300 miles, but the end of the wireless amateur insofar as the radiophones is concerned is in sight. Large concerns have invested thousands of dollars in the wireless telephone and are going to make it take the place of the ordinary line phone. This will be possible through the use of recently perfected interference eliminators. The long lines between central stations will go down first. Their place will be taken by the high power radio telephone transmitter. Although a number of years may elapse the local lines will be the next and last to go down. Their place will be taken by short range radio telephone sets operating as before in conjunction with a central exchange.

It suffices to say that when wireless telephones become universal there will be no novelty connected with them and the amateur will look for fresher fields of experimenting which will not be the wireless telephone.

J. Stanley Brown.

Good Sense Dictates the Design and Mounting of a Radio Set

THE term "radio amateur" is synonymous with "experimenter." His motto is efficiency spelled with a big "E" and he forever strives to increase the range of his set with unceasing vigilance and tireless energy. In order to secure this increased efficiency, it frequently becomes necessary to rearrange and change the connections of the apparatus. Then too, in the event of the adoption of some new and up-to-date piece of apparatus corrections are also necessary.

When the instruments are mounted on a panel, they usually present a more "commercial" appearance, much desired by some amateurs. However, the progressive element are more desirous of results and are willing to sacrifice mere appearance for range. It is upon this element that progress in the art is dependent. Since it is the customary condition of the average amateur to be financially embarrassed, which means that his funds are inadequate to secure instruments which he

knows will increase the efficiency of his transmitter, he will readily realize the economy of a practical and efficiently grouped arrangement of instruments. In case that he already has the instruments mounted neatly on a panel and sees that the arrangement is inefficient or an individual piece of apparatus has become defective, the cost of making the changes are increased and it is very likely that the appearance of the panel will suffer thereby.

So that if the amateur will content himself with a neat arrangement of his instruments with a view of securing maximum efficiency through shortening the connecting leads, etc., he will be amply rewarded by a corresponding increase in the effective range of his transmitter.

P. L. WELKE—*Maryland.*

Suggestion for Prize Contest OCTOBER Wireless Age

We will pay the usual prizes of $10, $5 and $3, in addition to our regular space rates, to the three contributors who send us the best manuscripts on the following subject:

What type of oscillation transformer is best suited mechanically and electrically for 200-meter transmission and what are the constructional details?

Hawkeye Radio Association

ALL radio men residing in Iowa should register their names and addresses together with all information concerning their experience, with Mr. J. W. Silcott of Brooklyn, Iowa. Reorganization of the Hawkeye Radio Association has been started by a few of the old members under a new plan with a larger scope of action. This plan is similar to that described in the February, 1919, issue of the WIRELESS AGE.

The Association would be glad to hear of the plans of other middle west organizations. It is believed that certain details of the work of a state organization could be carried out better if all state organizations could be "leagued" together. In order to do this, there should be a similarity of scopes and aims.

The H.R.A. would like to hear discussions of the above plan.

Amateur Wireless Telephony

PRACTICALLY every live, up-to-date amateur has read and studied something of radio telephony. There have been innumerable articles and books on this subject describing the theory and practical uses of the wireless telephone. Some articles even tell how to make a small vacuum tube transmitter.

Amateurs will undoubtedly experiment a great deal along these lines and probably an efficient short distance set will eventually result. If correctly designed, a small transmitter using the ordinary audion bulb and having about 100 volts in the plate circuit is capable of transmitting the voice from three to four miles. By connecting another bulb in parallel and increasing the plate voltage, the range may be increased. A set of this kind may be easily constructed by the amateur, because many of them own audions. Although it is not meant to go into constructional details, it may be said here that it is fairly simple to construct a low amperage storage battery out of test tubes and lead strips, which, when charged by a home-made electrolytic rectifier is capable of delivering one hundred volts or more. It is, therefore, safe to say that many experimenters will construct sets of this kind for local work.

The range of communication, however, is limited. The only reason radio telephone transmitters of sufficient power to send 100 miles or over will not be used among amateurs, is their high cost. A set of this kind requires a high D.C. plate voltage, probably of at least 500 volts, and as alternating current is usually the only kind available some sort of rectifier must be used. Even then, a 500 volt A.C. source must be had. The only other way of getting high D.C. voltage is to use a motor generator.

The total cost and up-keep of such a set may be beyond the means of the average amateur. Of course, advanced experimenters may, and in all probability will, make and use sets of this kind but they are of small number.

In summary, it may be said that wireless telephony will, in the near future rival, if not take the place of wireless telegraphy in local work; that is, within a radius of about ten miles. For all other radio work, wireless telegraphy will hold its own. An efficient one kilowatt station will transmit reliably a distance of 300 miles and if a special short wave regenerative receiver is used at the receiving station, the range may be further increased. A radio telephone transmitter of this range would cost many times as much to construct and be much more expensive to operate.

RALPH FOSS—*Illinois.*

Queries Answered

Answers will be given in this department to questions of subscribers, covering the full range of wireless subjects, but only those which relate to the technical phases of the art and which are of general interest to readers will be published here. The subscriber's name and address must be given in all letters and only one side of the paper written on; where diagrams are necessary they must be on a separate sheet and drawn with India ink. Not more than five questions of one reader can be answered in the same issue. To receive attention these rules must be rigidly observed.

Positively no Questions Answered by Mail.

R. B. C., Los Angeles, Cal.:

The "hard" Marconi V.T. will meet your requirements. The "soft" bulbs are particularly suitable for detection purposes.

A book will shortly be issued by the Wireless Press that will give full details concerning the construction of an amateur wireless telephone set capable of working fifty miles. Low power vacuum tube transmitters, say of 10 watts output, do not require an induction coil to modulate the antenna currents. It will be sufficient to connect the microphone in series with the earth lead, shunting the microphone with three or four turns of copper wire wound on a mandrel 4" in diameter.

It is recommended that you purchase a small 500 volt generator to energize the plate circuit of your transmitter. One hundred dry cells will not give a potential of 250 volts.

Regarding the diagram in the Wireless Age: the middle tap leading to the tube filament need not be variable, but the taps leading to the grid and plate circuits should be variable.

In the second edition of "Vacuum Tubes in Wireless Communication" you will find up-to-date diagrams of tube transmitters, the construction of which is for the most part self explanatory.

* * *

C. S., Bishop, Cal.:

You should have no difficulty in selecting from the advertising columns of this magazine a receiving set that will meet your requirements. Several amateur manufacturers can supply you with a long wave set.

* * *

F. G. S., Graniteville, Mass.:

We do not know of any manufacturer that will supply you with a vacuum tube wireless telephone set. So far this apparatus has only been manufactured for the government. Any vacuum tube receiving set will record wireless telephone signals.

* * *

J. R. P. Jr., Parkersburg, West Va.:

You can reduce the power input of your transformer to 1/2 kw. by connecting a reactance coil in series with the primary. Wind up a choke of 4 layers of No. 10 wire on a core 2" square and bring out several taps at regular intervals. The core should be 14" long.

* * *

A. S. K., Great Lakes, Ill.:

Regarding the variometer described in the May issue: It is intended that the field frames have 30 turns each, and the rotating balls 32 turns each.

* * *

H. S. W., Dover, Ohio:

You will undoubtedly find it a difficult matter to eliminate the inductive interference from the high tension power line you mention. Some amateurs have achieved success by running a small aerial parallel to the power line and coupling it inductively to tuner secondary in such a way that the currents induced in the receiving circuits will be opposed.

* * *

H. G. F., Bensenville, Ill.:

The vacuum tube detector is by far more sensitive than silicon or any other crystalline detector. All of the textbooks

issued by the Wireless Press, pertaining to radio, contain diagrams applicable to your needs.

* * *

A. B. L., Chicago, Ill.:

The secondary of a spark coil or a high voltage transformer often is suitable as an intervalve coupling in a cascade amplifier.

The impedance of the intervalve coupling should at least be equal to the internal impedance of the tube. If the impedance of the tube is known, a number of secondary transformer pies of equal impedance can be selected. The impedance of any choke may be measured by connecting it in series with a 500 cycle source. A voltmeter should be connected across the coil, and a milliammeter in series. The reading of both should be noted and the resulting data inserted in the formula $Z = \frac{E}{I}$, where Z = the impedance in ohms.

Some telephone receivers have sufficient impedance to be used as intervalve couplings. The impedance of one standard head-set at 500 cycles is 22,000 ohms. Two such telephones in series will be sufficient for the average valve.

Two megohm resistances are used as intervalve couplings with the Marconi V.T. A booklet accompanies each valve showing the best circuits for reception.

* * *

D. R. J., Boston, Mass.:

The bi-directional, direction-finding set is practically as good as the uni-directional instrument. The latter is a little more difficult to adjust than the former, particularly when it comes to making the first calibration. A single frame aerial 4 or 5 feet square will do for long wave reception provided a cascade amplifier is employed. Signals have been received several thousand miles with coil aerial erected indoors and outdoors. They are entirely practical for amateur communications provided the receiving set is sufficiently sensitive for long distance working. A book will shortly be issued by the Wireless Press giving complete data on such aerials.

* * *

K. R. Z., Schenectady, N. Y.:

Merchant vessels are gradually being returned to private ownership and as this is done, the naval operator is replaced by a civilian operator. There are plenty of opportunities for employment. It is, in fact, somewhat difficult to keep pace with the demand for qualified radio operators. Only those possessing first grade government license certificates are employed in the Marconi service and many appointments are made each week. The situation in so far as the operator is concerned was never better. Good salaries are being paid and permanent employment is assured to those who make good.

It requires about four months instruction to train a beginner to pass the government license examinations. Some men require a longer period of training.

* * *

B. L. A., Andover, Ohio.:

A "Vernier" variable condenser is of considerable value in vacuum tube receiving sets, particularly when receiving wireless telephone conversations. Extremely close tuning is necessary for the best results.

The only high power wireless telephone station at present in operation is that located at New Brunswick, N. J. The output of a 200 kw. radio frequency alternator is modulated by a magnetic amplifier which in turn is controlled by a bank of vacuum tubes and a microphone. We are not familiar with the exact schedule but the station is frequently heard talking at the wave lengths of 8,000 meters and 13,600 meters. The antenna current at New Brunswick for telegraphy is 450 amperes.

September, 1919 20 Cents

The WIRELESS AGE

Volume 6 Number 12

Wireless Achievements in the A. E. F.

By Lieut. Col. L. R. Krumm and Capt. Willis H. Taylor, Jr.

Across the Ocean on the NC-4.

Second Instalment, by Ensign Rodd

HATS OFF TO THE NAVY

INSULATION
"MADE IN AMERICA"

TRADE ELECTROSE MARK
REG. U.S. PAT. OFF. & FOREIGN COUNTRIES.
Louis Steinberger's Patents

INSULATION
"MADE IN AMERICA"

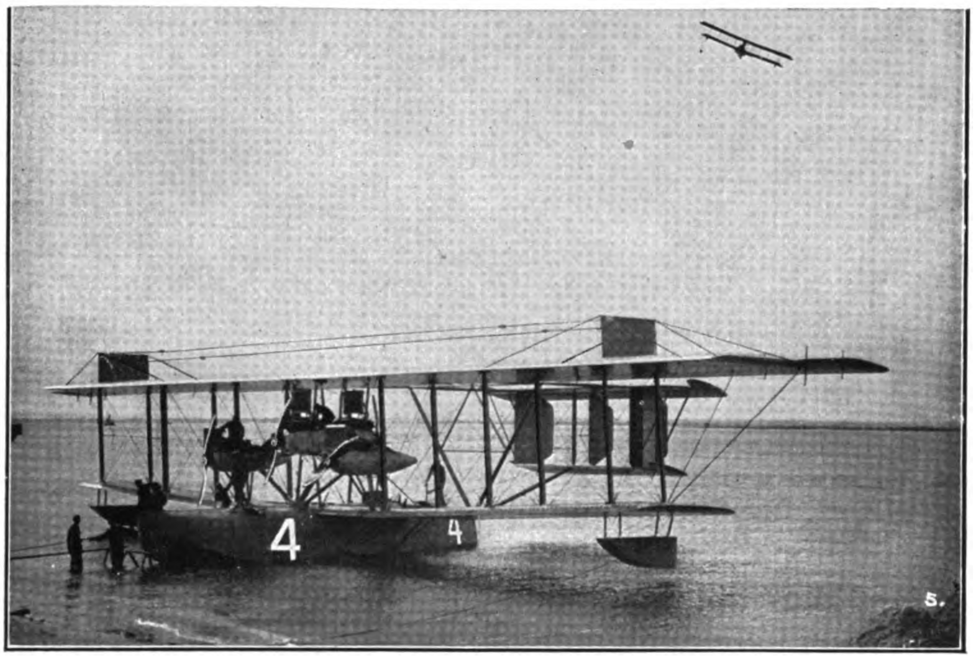
ELECTROSE INSULATORS—

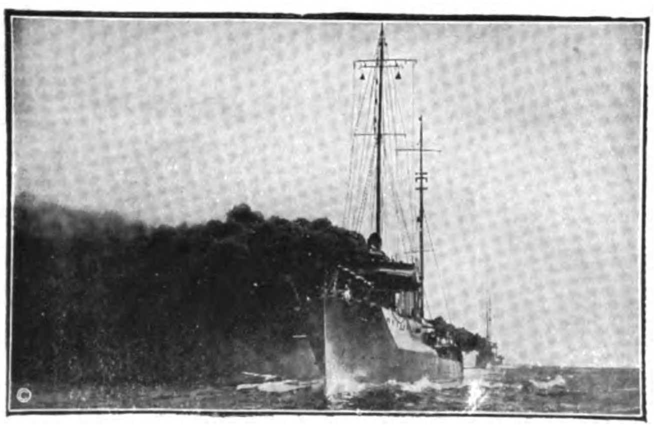
FIRST TO CROSS OCEAN IN AIR

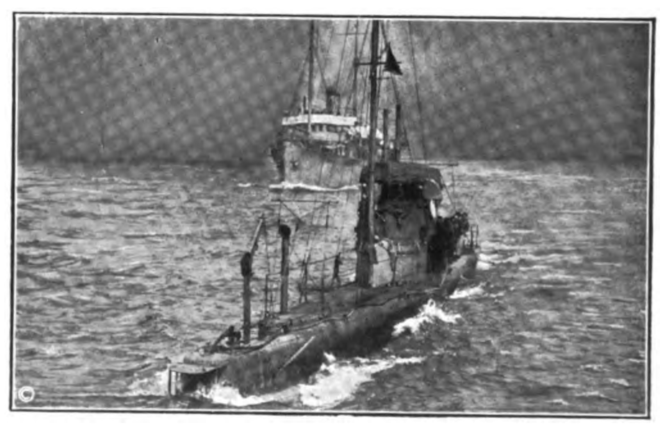
Standard of the World for High Frequency Currents Used by UNITED STATES NAVY and ARMY, and the Wireless Telegraph and Telephone Companies

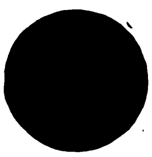
"By courier, coach and sail-boat, it took days for the news of Waterloo to reach London. During Lieut. Commander Read's flight to Halifax, Assistant Secretary Roosevelt in Washington sent a radio message to NC-4, of whose position in air he had no knowledge. In three minutes he had a reply."

Extract from New York World, June 3, 1919.


NC-4—ELECTROSE Equipped.


U. S. S. Cassin and U. S. S. McDougal Working Up a Smoke Screen—ELECTROSE Equipped.


U. S. S. G-2—ELECTROSE Equipped.


Medal and Diploma received at World's Columbian Exposition, Chicago, 1893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INSULATION
"MADE IN AMERICA"

LOUIS STEINBERGER'S PATENTS


Medal and Diploma received at World's Fair, St. Louis, 1904


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The Wireless Age

Edited by J. ANDREW WHITE

Vol. 6 — No. 12

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Index of Equipment

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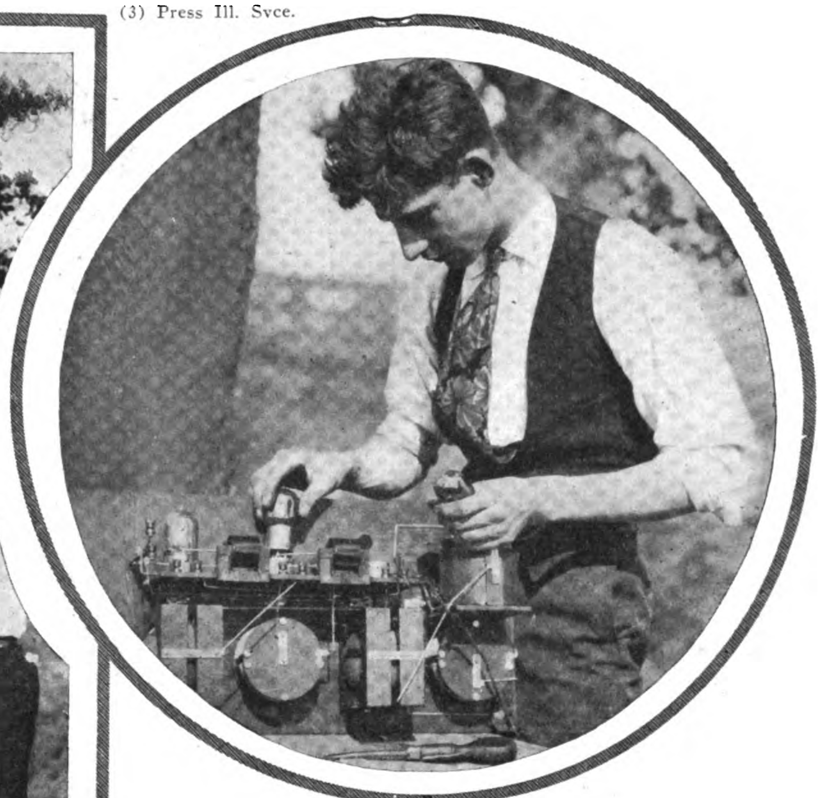
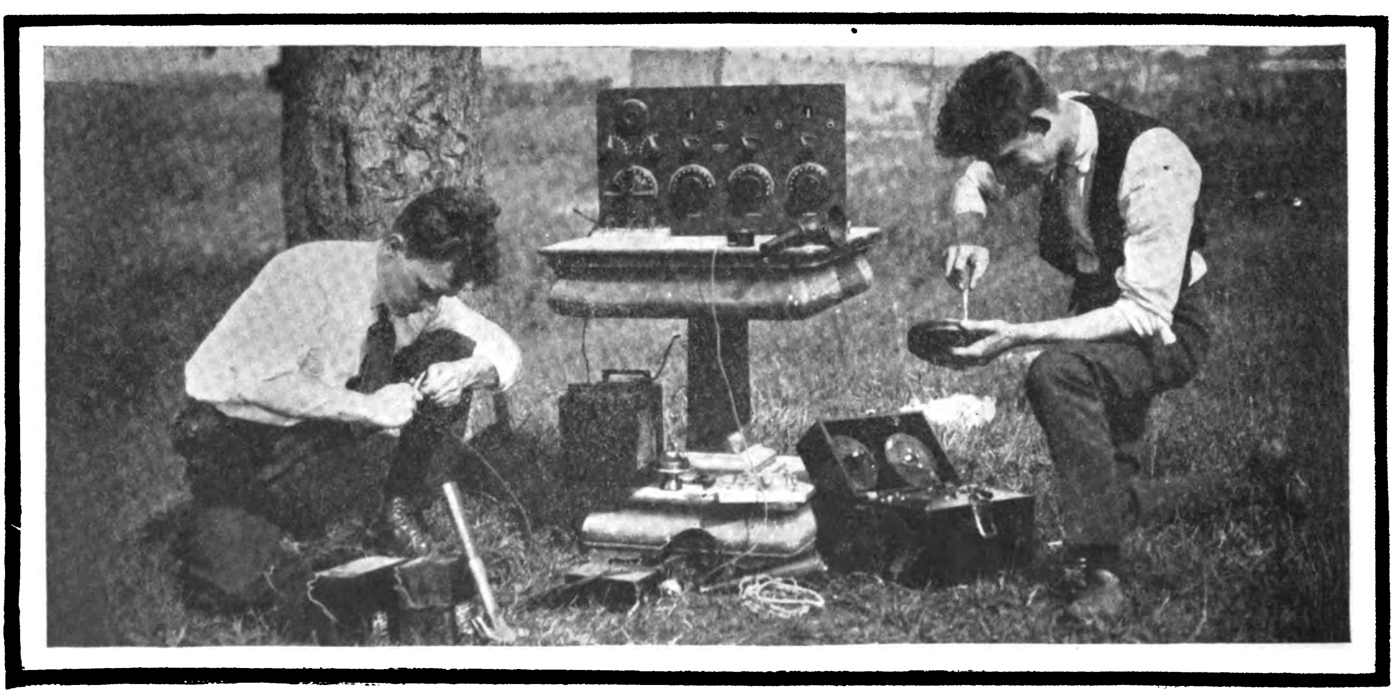


Wireless in the Wood

So considerable were the improvements made in the use of tree antenna for wireless communication during the war period that interest has been revived in amateur experiments along that line. Long distance transmission and receiving, duplex operating and radio-telephony has been accomplished

The receiving apparatus shown above is of the modern type; the picture shows the rear view with the Marconi V. T. bulbs being placed in position

On the left is a view of the method of rigging the lead-in wire



Walter Wehmann on the left and James Candido on the right are two of the number of tree-antenna-enthusiasts

Vol. 6. No. 12. September, 1919

THE WIRELESS AGE

WORLD WIDE WIRELESS

New Method of Producing Electric Current for Use in Wireless

ACCORDING to "Norges Handels og Sjofartstidende," Engineer Hermod Peterson has recently patented a device for the production of electrical current for radio-telegraphy. The electricity is received by an accumulator, which releases it at certain intervals. The system is sparkless, and the sounds are clearer than in the older inventions. The clearness of sound depends upon the regularity of the current, and with this system the current is released with a mathematical exactness. The device has further advantages in that it is cheaper, simpler, and more durable than those now in use.

If the claims made for this invention prove well founded it is thought that it will mark a distinct step in advance of what has so far been accomplished in this line, and hence its possibilities are creating considerable interest in the radio world.

Wireless to Aid Mail 'Planes

THE Post Office Department has contracted for the erection of three high-power radio stations, the first of a chain of wireless communicating centres in various cities to be used primarily for the direction of mail-carrying airplanes handicapped by fog.

Stations will be established at Bellefonte, Pa., and Cleveland, Ohio, with a third at some point on Long Island or at Newark, N. J. Appropriations for them already are available. Others will be erected at Washington and Chicago as soon as Congress provides funds.

Each station will be equipped with steel towers 200 feet high and 300 feet apart and will have a range of approximately 400 miles to mail airplanes and approximately 700 miles between stations, the difference in range being due to the lesser sending ability of airplane wireless equipment.

Establishment of the radio stations will enable the Post Office Department to maintain communication between cities having air post delivery independent of telegraph and telephone services in the event of a disruption of service by storms or other causes.

Wireless and the Hidden World of Vibrations

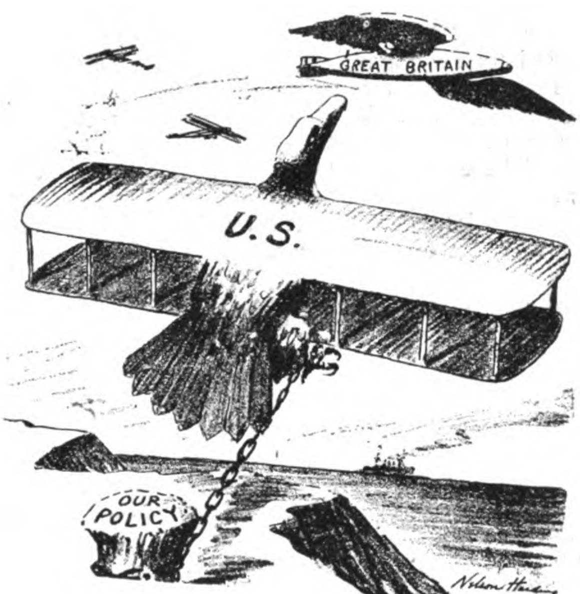
THAT communication with the dead may be made as commonplace a matter as is wireless communication with a person in Europe at the present time, was the remarkable statement made by Dr. Frederick Finch Strong, of the Krotona Institute at Hollywood.

Experiments have been made there, it was announced, demonstrating the methods which, when further extended, will accomplish this amazing result.

The Krotona experiments give rise to the hope that a technique, whereby new forces and kinds of matter may be revealed.

A sort of transformer process for the dull human senses is being worked out in the hope of proving by means of actual communication with the dead the theory held concerning the continuity of life after death.

One experiment which leads to the belief that any number of things may be camouflaged under a kind of color which makes it impossible for the eye to detect is with ultra-violet rays. Rare minerals, which respond to certain wave lengths, take up and transform them so that they become visible.



Yes, American Aviation Is Looking Up.
—Harding in the Brooklyn Eagle.

Playing Checkers by Wireless

A GAME of checkers by wireless has been played by two Delaware men, who flash their moves back and forth through the air between Wilmington and Greenville, Del. They are Fred R. Fooding of Wilmington, an official of the Delaware Bank and a licensed radio operator, and William Anderson of Greenville, a student at Delaware College.

The first game of the series lasted an hour and a half. At the end of the period each player had six men on the board. As each player flashed his move on the checkerboard to his opponent he made the move on the board in front of him, which was duplicated by his opponent.

This item is contained in current news, without any explanation, however, of how the ban on transmitting was overcome.

Marconi International Cable Code

IT is announced that the Marconi international cable code, being published in parts of the United States and Great Britain as rapidly as completed, will, for the first time in history, permit people of nine languages intelligibly to communicate with each other without need of translators. The languages to which the code is adaptable are English, French, Spanish, Portuguese, Italian, German, Dutch, Japanese and Russian. Since the code includes phrases of commerce, law and finance likely to be used, however technical, it will be very voluminous and will, for practical purposes, far surpass Esperanto or any other artificial language for international use. The code words will be the same, but, of course, there will be necessity for a book for each of the nine languages. It is said that hundreds of business experts and linguists have been engaged for three years in preparation of the code, and it has been called "the concentrated essence of a lifetime of code study and compilation."

Not only can an American business man, by consulting the English code book, send a code message to a Spanish merchant, which the latter can immediately transcribe by looking up its meaning in his Spanish code book, but the misunderstandings so common in the translation from one language to another will be obviated. The message will be concise and unequivocal to the Spanish as well as to the American. It would be hard to overestimate the advantage that such direct communication will be in facilitating international business.

Marconi took a gigantic step in annihilating distance and bringing nations together when he completed the commercial wireless. The international cable code provides one of the greatest facilities for making it effective. There are other changes, in the interest of better service, such as a condensed manner of sending figures and a letter combination code that permits the sending of two words for the usual cost of one.

Conquering Fog by Means of Wireless

GUGLIELMO MARCONI'S new invention for the purpose of protecting vessels during a fog was discussed recently at the annual meeting of the Marconi International Marine Communication Company, Ltd., in London. Godfrey Isaacs said:

"This new discovery provides a means whereby a ship in the densest fog may discern the approach of another ship, provided that that ship be also fitted with this apparatus, at the same time giving an approximate idea of the distance of the approaching ship. We are at present engaged in giving commercial shape to this new apparatus, and as soon as possible its value on board ship will be demonstrated. We have great hopes that by this means all risk of collision at sea during the thickest fogs will be eliminated, to which end, of course, every ship would have to carry the apparatus, for it stands to reason that if a great liner were fitted and a small tramp were not, the danger of collision and the loss of one or the other, or both, of the ships might result.

"Inasmuch as this new device should provide means of disposing of that which is so great a danger in misty and foggy weather, it is not unlikely, we think, that every ship which goes to sea will be eventually fitted with this new installation, and we shall all be spared the harrowing accounts of the terrible losses which from time to time it has been so distressing to read in the daily press resulting from some terrible collision at sea."

Wireless Between U. S. and Germany Resumed

WIRELESS communication with Germany has been resumed in a limited way by the American government. Business communications between American houses and their agents in Germany are accepted in New York at 44 Whitehall Building, and other points where the navy has district communication officers for transmittal to the trans-Atlantic wireless stations at the Navy Department here and at Otter Cliffs, Me., where they are dispatched to the receiving station at Nauen, Germany. Similar communications are dispatched from Nauen to the United States stations. Press dispatches to the extent of 500 words from this country and a similar number of words from Germany are also accepted daily.

British Government Pays $2,950,000 to Marconi Co.

AN AWARD of £590,000 ($2,950,000) damages was given to Marconi's Wireless Telegraph Co., Ltd., in a suit for breach of contract brought against the British government. The contract was in connection with the construction of the Imperial Wireless System.

The Marconi Company claimed it was entitled to £7,180,000, basing their claim on a provision in the contract that it was to receive royalties amounting to 10 per cent on the gross receipts from the stations for the entire period of the contract, which was to have run for twenty-eight years. The government claimed the damages payable to the company amounted to £50,000.

Wireless on All Ships Over 150 Feet Long

THAT all passenger ships more than 150 feet in length entering or leaving any port or harbor in the United States shall be equipped with wireless is provided in a bill introduced in the House at Washington by Representative Britten, of Illinois.

It is provided also that all United States Coast Guard stations shall be equipped with wireless.

Increased Earnings of English Marconi Co. for 1918

MARCONI'S Wireless Telegraph Co., Ltd., reports for 1918 a profit of $1,989,500 against $1,919,000 in 1917. Dividends on the ordinary shares were increased from 20 to 25 per cent and on the preference shares from 17 to 22 per cent. General reserve was increased by $750,000 to $7,250,000. Shares of associated companies are shown in the balance sheet at a cost price of $6,825,000, compared with a present par value of $11,730,000.

Energy Transmitted on Wireless Waves.

WIRELESS telegraphy and wireless telephony, now commonplaces, suggest the possibility of transmitting energy by wireless waves. A Roumanian engineer, M. Constantinesco, has been experimenting in England with a method that seems novel.

He uses a tube filled with water or some such liquid in which vibrations of the nature of sound waves are produced at one end and the energy is reconstructed at the other end in a mechanical form. The details of the apparatus are kept secret, but Constantinesco's researches have been financed by the British government, and it has already been applied in the mechanism that stops the discharge of bullets from the rapid firing gun of an airplane each time that the blade of the propeller passes before the muzzle.

Wedded by Wireless While Flying in Airplanes

MISS EMILY SCHAEFFER of Sea Gate, L. I., and Lt. George Burgess of Brooklyn, were the principals in a wedding ceremony that featured the second of the two Police Field Days held at Sheepshead Bay. They flew in a plane piloted by the groom who is an aviator attached to the Mineola forces. In the second plane the Rev. Alexander Wouters of the Edgewood Dutch Reformed Church, the first real "sky pilot," flew, with Lt. Eugene Barksdale, the best man as pilot. A long streamer of bunting indicated the bride's plane.

Dr. Wouters conducted the service with the aid of a wireless telephone. The bride and groom were fitted with telephones too. Gov. Smith and Mayor Hylan had receivers, and there were thirty-two receivers for that many of the bridal party in the grand stand.

Besides that, there was a megaphone-like do-dad in front of the centre of the grand stand from which the voices of the contracting parties and of the minister issued. More than 100 persons, who were crowded round, probably heard the voices from this instrument.

Mrs. Burgess, who is 26 years old, the same age as her husband, now a radio instructor at Mineola, tells a thrilling tale of how she met Lieut. Burgess.

"I met my husband, Lieut. Burgess, about six years ago when I was canoeing with a girl friend. He was then the assistant manager of the radio station of the Marconi Wireless Telegraph Company at Sea Gate. The canoe suddenly pitched, as canoes do, and my friend was thrown into the water. The lieutenant saw the accident from the shore and came to our aid in a boat. He rescued my friend and of course we thanked him and our acquaintance began.

"I am interested in the radio code and understand it. When we talked over our wedding, it was suggested that we get married in an airplane by radiophone to demonstrate its wonderful possibilities."

Big Danish Wireless Station

OFFICIAL announcement in Washington that Denmark is making plans to open wireless communication between Copenhagen and the United States, has been made by the Danish Legation. This statement has been made public:

"Information to the effect that regular wireless connection has been established between Denmark and Great Britain has just been received by the Danish Legation here. Plans are now being worked out by the Danish Ministry of Traffic for erecting a great trans-Atlantic radio station near Copenhagen which will put Denmark in direct wireless communication with the United States.

"Danish newspapers complain that their telegrams for some time have been greatly delayed because of the crowded cables. The Danish papers express the hope that the still important plan for a great trans-Atlantic station will soon be realized. The Danish press is anxious to get into direct communication with America so as to be able to obtain news from over here at first hand and at reasonable rates.

"The Danish wireless station at Lyngby is at times able to hear the American station at Arlington talk to Rome, but is not powerful enough to send messages over the Atlantic. The plans now under consideration by the Danish government call for the erection of a trans-Atlantic wireless station."

Postal Wireless Service Throughout British Empire

POSTAL wireless service, to extend throughout the British Empire, has been provided for by the House of Commons in voting 170,000 pounds for the project. The first stations will be opened between England and Egypt. The service may begin by the end of the year.

Eiffel Tower Revives Ancient Custom

AFTER the peace treaty had been signed by Germany's representatives in the Hall of Mirrors at Versailles the Eiffel Tower wireless station sent broadcast the massage "Fermez les portes" ("Shut the doors"). The phrase, as many will understand, was suggested by the fact that when peace was declared in ancient Rome the doors or gate of the Temple of Janus were closed.

Lieut. Durrant of the R-34 Describes Wireless Equipment

LIEUT. REX F. DURRANT, wireless operator of the R-34, speaking of the radio apparatus used during the trans-Atlantic flight, said:

"We had the wireless direction finder on board, known as the maximum method. We had a range of 300 miles. We got very good bearings on Cape Race. All the Canadian wireless compass stations helped us a great deal in our navigation.

"We had a main transmission set using continuous wave with a range of 1,200 miles and a wireless telephone with a 100-mile radius. We also had an auxiliary continuous wave set and an emergency spark set. All these sets functioned perfectly during the voyage.

"We were never out of wireless touch up to the time we passed Newfoundland. We were in direct constant communication with Clifden, Ireland. We were in touch with the British Air Ministry every two hours. We held the Air Ministry wireless station on top of the Hotel Cecil in London half way across the Atlantic. In mid-ocean we were in direct communication with Clifden, Canada, and the Azores at the same time. We carried 400 feet of trailing aerial, for use on all the sets except the direction finder, which was worked by coils.

"The small spark set was excellent. Cape Race read it at 300 miles, although it had only one-tenth of an electric horse power.

"As a result of my experience on the voyage I am designing a larger coil for the direction finder set on these ships. Also, as a result of my experience it has been proved beyond doubt that continuous waves will be the future means of wireless transmission."

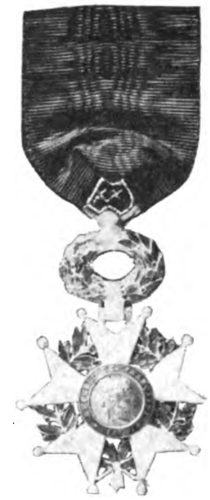
Marconi Wireless Rig on Yacht

THE yachts in the Long Island Star class in the annual race to Captain's Island and return included a Star boat with the new Marconi rig, so called because the method of arranging stays makes it resemble the mast of a wireless station. It is the first time that the righ has been put on a boat of this class, and the innovation was watched with the greatest of interest by all yachtsmen.

Donald Cowl is the Corinthian who is trying out the innovation. The yacht that he has altered was formerly the original Little Dipper, the property of G. A. Corry.

Distinguished Service Medal awarded in the name of the President by Gen. Pershing to Lieut. Col. Krumm for "exceptionally meritorious and distinguished services," due to "masterful ability and exact scientific knowledge"

Lieut. Colonel Louis R. Krumm



The famous French decoration, the Legion of Honor, conferred upon Lieut. Col. Krumm and establishing him among the few American officers who have been admitted as Chevaliers to the century-old order founded by Napoleon

The Authors of Wireless in the A. E. F.

Colonel Krumm is best known to wireless men as Chief Radio Inspector, Bureau of Navigation, Department of Commerce, a position which he has held since 1912. He has degrees of mechanical and electrical engineering from Ohio State University and for seven years served as an electrical engineer, Signal Corps. He was commissioned a reserve Captain in this branch of the service in May, 1917, and within three months was promoted to Major, sailing for France, Sept. 27, 1917. His elevation to the rank of Lieutenant Colonel preceded the Armistice by two weeks, recognition of efficient direction of the Radio Division during the entire term of his service in the A. E. F.

Captain Willis H. Taylor, Jr.

Captain Taylor, a graduate mechanical engineer of Stevens, received his reserve officer's commission as 1st Lieutenant, Signal Corps, two months after war was declared. For six months he was assigned to recruiting for the radio branch, going overseas in December, 1917. Four months later he became assistant chief of the Radio Division, A. E. F., and thirteen months after his enlistment was promoted to the rank of Captain. General Pershing mentioned him in a citation for "exceptional and meritorious services" as the officer responsible for the co-ordination of the work of the other Sections in the A. E. F. and maintenance of liaison with the Radio Division at Washington

Wireless in the A. E. F.

First Authentic Account of the Organization of the Radio Division of the Signal Corps and an Inside View of the Great Obstacles which Americans Had to Overcome

By Lieut. Col. L. R. Krumm

Officer in Charge Radio Division, Signal Corps, American Expeditionary Force

and Capt. Willis H. Taylor, Jr.

Co-ordination Officer, Radio Division, Signal Corps, A. E. F.

IT HAS been a commonplace saying in all articles relating achievements of the Great World War that it was a contest of science and skill.

In no branch of an army's activities is this better exemplified than in the utilization of the wireless method of communication. Thus the prepartion of articles recounting the work of the U. S. Army Signal Corps and its use of radio telegraphy and telephony for military purposes has presented the problem of selection from superabundance, leaving the authors confronted by the difficulty of picking out from the mass of material available those things which will best reflect the magnitude of the task and its accomplishment. In this and the succeeding articles of the series there will be set down without embellishment those historical and technical facts which appear to be of most interest. not alone to the radio profession but also to the general public.

The Authors in the headquarters of the Radio Division at Tours, France

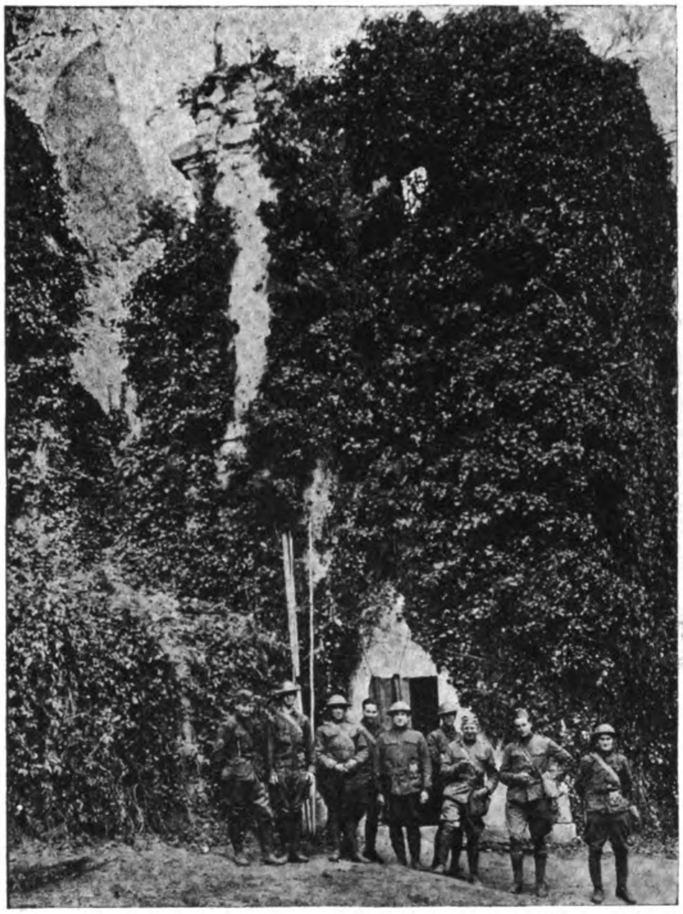
The absolute unpreparedness of the American Army for a war of the magnitude of this one is a matter of universal knowledge; nowhere was it better indicated than in the radio equipment and personnel available to the Signal Corps when this country entered the war. Only two types of military radio equipment had been developed and put in use; these were the ¼ kw. 500 cycle quenched spark pack set, adapted to be transported on mules and provided with a hand driven generator, and a 2 kw. 500 cycle quenched spark automobile set. Both were fairly good equipments of their types, quite satisfactory for warfare such as might be encountered on the Mexican border. Unfortunately neither of these sets was suitable for use in the European war, so that it may be said that the U. S. Army, at the time of the declaration of war against Germany, had no suitable radio equipment for its signalling troops. This was demonstrated. Some of these sets were sent to France, but were never used for transmission during operations. Practically all the radio equipment used by the American Expeditionary Forces was of French manufacture, for the development and production of equivalent material in the United States on a quantity basis was not accomplished until about the time the armistice was signed.

It is interesting to note that after the armistice, an effort was made to utilize one of the pre-war 2 kw. spark tractor sets at Spa, Belgium, to provide communication for the American section of the Armistice Commission which had its headquarters at that point, but its use caused such interference with the undamped wave sets of the stations of the other allied armies as to make the American army decidedly unpopular from a radio standpoint. The station had to be replaced by an undamped wave set, the sharper turning of which permitted the simultaneous operation of the different sets in that vicinity. Spark sets having more than 100 watts transformer input were decidedly *de trop* with the Allied Armies in France, and the extensive use of vacuum tube undamped wave transmitters—even with the very front line troops—was decidedly contrary to the previous practices or principles of our Signal Corps. In a later article a detailed description of these sets will be given; at this time it will be sufficient to say that the suitability of this type of equipment to meet the trying conditions of war communication was most thoroughly demonstrated. The many special functions of the radio personnel will also be described later, for it should be observed here that the diversity of employment was developed to a point which it is probable that few officers of the Army before the war had thought of, much less provided for.

Brigadier General Edgar Russel, Chief Signal Officer, American Expeditionary Forces, who arrived in France in June, 1917, had seen long service and distinguished himself as an officer in the Signal Corps, having served in Mexico and the Philippine Islands. He was well aware of the inadequacy of our Army's radio personnel and equipment and realized that it would not be easy to overcome the deficiencies. The problem of personnel was similar to that of all other branches of the service. Men could be given their initial and fundamental training in the United States contemporaneously with the training of the other services. But equipment in enormous quantities and especially constructed for war uses had to be provided from the beginning, and radio equipment of this character was not available in the United States. There were experienced American manufacturers to be called upon, but their capacity was limited and the large requirements of the Navy demanded added output. It soon became evident to General Russel that his supply must come from one of our Allies. Soon after his arrival he arranged with the French authorities to obtain from them the necessary radio and T. P. S. (ground telegraph) equipment for our troops until such time as these could be supplied from the United States. His foresight in this direction will be further emphasized in the story of supply.

The French Army made greater use of undamped wave sets than any of the armies. The probable reasons for this may be of interest. Prior to the war it was a well-known fact commercially that the German spark sets were superior to the French spark sets. At the beginning of the war, so French officers told us, the German Army's

radio equipment and communication was considerably superior. The French, realizing the necessity for better equipment, wisely appreciated the possibilities of vacuum tubes for transmitting and receiving; then decided, therefore, that the use of spark sets would be restricted to those types suitable for front line work, where simplicity is the controlling factor. For all other wireless communication they adopted undamped wave sets which used the same type of three-element tube for both transmitting and receiving, thus greatly simplifying their supply problem.



The very old and the ultra-modern joined hands in wartime when a divisional wireless station was installed by American men of the Signal Corps in this ancient chateau, erected about 500 A. D.

Now as to the importance of wireless. Radio telegraphy, it must be remembered, is essentially the emergency communication method of the Army. In trench warfare where positions were permanent and troops did not change their lines—in some cases for years—wire communication was preferred and desired: very complicated wire systems were installed and maintained even under conditions of greatest difficulty. But even in these positions, radio stations were provided to take up the burden of maintaining communication in time of heavy shelling, when the wires were broken and could not be repaired. In mobile warfare, on the other hand, radio immediately demonstrated its superiority over all other means of communication and those officers best qualified to judge are convinced of its even greater utilization in future wars.

Radio operations take on the general character of the other activities of an army in that, in a general way, they can be divided into offensive and defensive classes. The use of this classification in regard to communication may seem strange, but it can be easily explained. Offensive radio may be considered as its use in establishing and maintaining communication during battles or other operations in the same manner as the telephone and telegraph or visual signals are used. The superiority of radio at such times is at once evident, for any method of communication requiring wires is too difficult to erect and is entirely too vulnerable to injury in the deluge of artillery projectiles hurled in modern battles.

The one fault in wireless communication which has not been practically overcome to date, although the problem is now under consideration in many laboratories, is that it cannot easily be made a selective or secret means of communication. The fact that all radio work can be heard by the enemy brings us to the so-called defensive radio. If the enemy can overhear your radio stations, he is equally handicapped by the fact that you can hear his, and therein lies your opportunity to profit by the old adage that "forewarned is forearmed."

In the mobile warfare that brought us the victory, ground telegraphy proved to be practically worthless and will probably be displaced in future wars by small wireless sets using loop antennae.

Wireless equipment for tanks was one of the problems that long defied solution. A set was finally developed that makes possible communication with the post of command and co-operating airplanes.

As might be expected, military communications are never transmitted in plain language. Code is always used. Cipher has been discarded because it requires too much time to encipher a message for transmission and because it can be accurately deciphered by mathematical methods.

Phrase code was used principally, and was frequently changed. In spite of all precautions, however, one of the main sources, if not the main source, of intelligence regarding the enemy's projected operations lay in the interception of messages by the Radio Section (Intelligence) of the Signal Corps. These Radio Sections (Intelligence) were the defensive radio organizations of the army. Whereas each combat division numbered among its troops a Field Signal Battalion included in which was one company of 75 men, assisted by certain men of the outpost company and some from the infantry signaling detachment, which was expected to maintain the radio communication within the division, the Radio (Intelligence) Section was not attached to any unit smaller than an Army and was expected to cover our entire front and operate wherever needed. In addition to the duty of intercepting messages from ground and airplane radio stations of the enemy, these men were charged with the responsibility of locating them by direction finding or goniometric stations, noting the channels of communication and every characteristic that might tell us how many and what troops were opposing us, and their probable plans for our future destruction. How the plotting of the location of stations and channels of communication clearly indicated the enemy's organizations is a fascinating subject; the methods used will be explained in a future article, as well as the counter efforts of the enemy to confuse our radio intelligence operators.

Included in the duties of the Radio Section was the operation of the so-called Listening Stations. These stations were intended to intercept all messages from the enemy's T. P. S. (ground telegraph) stations and all grounded telephone or telegraph lines. Grounded lines were never intentionally used by any army in the latter part of the war, but no electric circuit could be maintained in a proper state of insulation and balance which would prevent our listening stations intercepting the

messages carried thereon if it was anywhere near us, as was the case during the position or trench warfare stage.

Low frequency amplifiers were connected to long leads running to grounds placed as near the enemy lines as possible. The stations were necessarily installed in dugouts within a few hundred feet of the front line trenches and the experiences of the men who were assigned to operate and maintain these stations were among the most heroic of the war. As the effectiveness of these stations depended upon the nearness of their grounds to the enemy's wire lines, our men when carrying these ground wires over into the enemy's territory, performed some of the most daring deeds of the war. One of the subsequent articles of this series will tell how these expeditions were carried out; how one of our men actually went over into the enemy's trenches and connected to important lines of telephone communication, enabling us to intercept Hun conversation for several days before it was discovered.

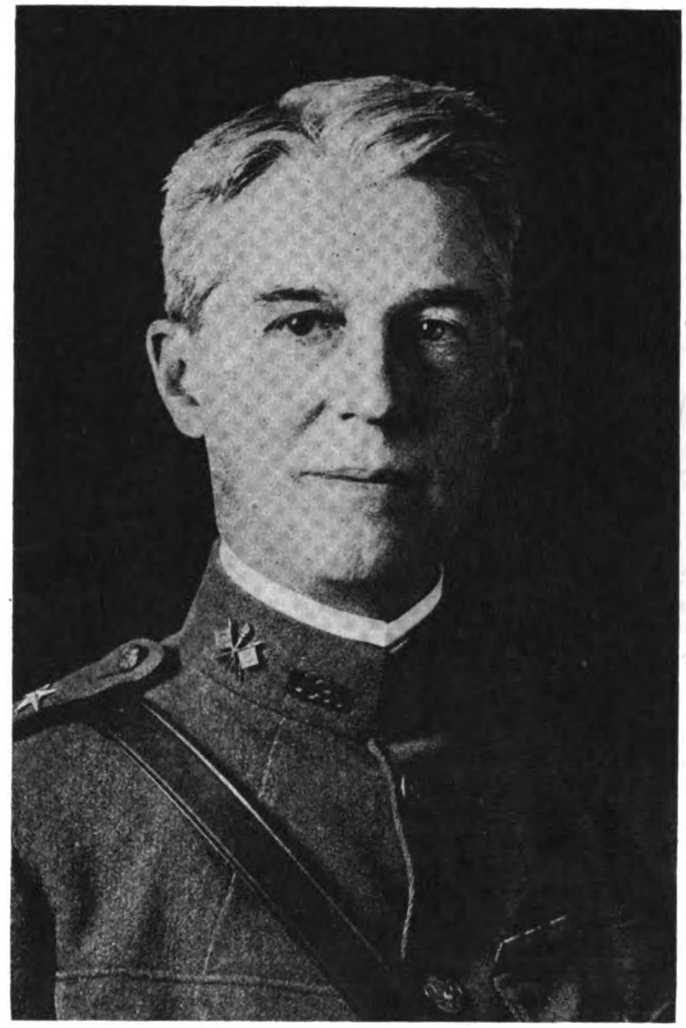
This ground telegraphy—developed by the French during the war and known to them as the T. P. S. (Telegraphie par Sol)—was made practically possible by the development of amplifiers utilizing three-electrode vacuum tubes. The transmitter consists essentially of a 50-watt induction coil, the primary circuit controlled by a telegraph sending key in series with the storage batteries carried as the source of power. The secondary of the induction coil is grounded through wires carried to grounds about 100 yards apart. Transmission is effected by the lines of flow of current between grounds which are intercepted by the receiving station. Audio frequency amplifiers, such as were used in the listening stations, were used for receiving, the receiving amplifier being also connected to ground plates separated by distances of 100 yards or more. It is a very crude means of communication, because of its efficiency being so dependent on local conditions; its use therefore, was necessarily limited, but in trench warfare of fixed positions it served very well in many places of favorable terrain.

One of the main sources of intelligence regarding the enemy's projected operations lay in the interception of messages by the defensive radio organizations of the U. S. Army.

So-called listening stations were installed in dugouts within a few hundred feet of the front line trenches; the experiences of the men who were assigned to this duty were among the most heroic of the war.

In the mobile warfare that brought us the victory it proved to be practically worthless and ground telegraphy will probably be displaced in future wars by small but efficient portable radio sets using loop antennae. In open warfare T. P. S. stations soon lost track of their relative positions and consequently lost their communication when endeavoring to establish a station in a new position. One of the greatest defects in this means of communication was found in the necessity for the long ground leads which were difficult to maintain, and the requirement for ground circuits of the receiver to be in such relative position as to intercept a maximum of potential and current. The system was never reliable for more than 2,000 yards, and then only under the most favorable conditions. Where a river or other low resistance path for electricity intervened between the transmitting and receiving station the distance was reduced proportionately. But for several years T. P. S. was the main reliance of the French, and for a time of our own troops for front trench line emergency communication. In an attack at Seicheprey our troops in repelling the attack used this means of communication, whereas the Boche carried over with him a portable radio set of the spark type and also a telephone line which was extended with the advance. His reasons for carrying the radio seemed rational, and judging from the telephone circuit, he evidently expected to occupy the position permanently. The fact that both means of communication fell into our hands before the fight ended indicated a miscalculation on his part.

The enemy also used ground telegraphy in the front trenches which made the establishment of our listening stations essential, so that these could fulfill their intelligence-gathering function for this means of communication exactly as did the radio intercept stations in gathering the enemy's messages from the air.

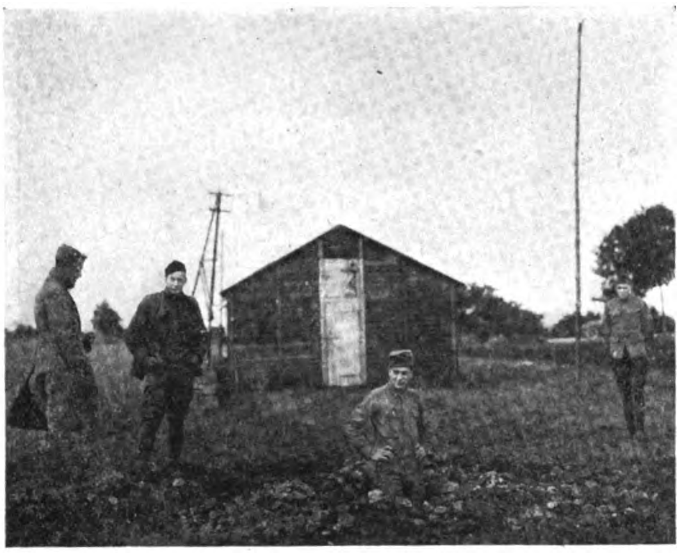


Brigadier General Edgar Russel, Chief Signal Officer, A. E. F., who early in the war realized the inadequacy of our army's equipment of apparatus and personnel; his foresight contributed largely to the eventual success of the American signalmen

Ground telegraphy (T. P. S.) messages were coded of course, but no code or rules or regulations have ever been devised which will prevent indiscreet conversation over the telephone. German efficiency experts evidently failed to devise any means to prevent these leaks and German conversations were constantly overheard. This required that all of our men employed in listening stations should understand German readily, as well as have the ability to record telegraphic code. As a matter of fact ground telegraphy sending is necessarily slow; interception of the code was found to be much easier than the determination whether a faint gutteral voice from the enemy's line was demanding more ammunition or more men. At first we endeavored to get German-speaking radio operators, but

the supply was limited; so we selected men who understood the German language and taught them code at the same time when we were coaching them in the use of the equipment and the German military phrases they might expect to overhear.

Another, and possibly the most important function of these listening stations, was the so-called "policing" of our own telephone lines. We knew that alert German ears were also pressed to receivers of their listening stations and could overhear indiscreet language on our lines. Code names were provided for all places, units and common subjects of conversation over our lines, but in the press of action—and, sometimes, even in the quietest hours—our officers failed to realize the danger of using plain English and neglected to obey the orders and instructions forbidding its use. Our listening stations were constantly on the alert for these indiscretions and many a high ranking officer was embarrassed by having a verbatim report of his careless words handed him a few minutes after he had completed a telephone conversation.



A radio intelligence detachment was housed in this old barracks when the Boche became suspicious and put over a few shells; the soldier is standing in one of the resultant holes

As has been stated, a perfectly balanced insulated metallic telephone circuit cannot be overheard, so that the condition of the line was also revealed by these stations and immediate steps would then be taken to repair the circuit in question.

We learned how the enemy appreciated the potentialities of our listening stations when our troops captured some German trenches in the latter part of the war. Their telephones were sealed up and captured orders indicated that these phones were only to be used in the greatest emergency; the officer breaking the seal was required by these orders to send in a written report as to the necessity for its use. In some parts of the line, as far back as two miles from the front, German telephones were found to be sealed up, indicating a respect for our listening stations exceeding our own, for we did not expect them to be over that distance.

All of the various fields of military radio activity so far outlined were practically a sealed book to the American Army before its entrance into the war and the gigantic undertaking of training and equipping the personnel for this work represents one of the greatest achievements of our army. Lt. Col. Krumm sailed for France in September, 1917, with as little real knowledge of the task before him as many of his readers. Samples of some of the French radio and T. P. S. equipment had been shown to different officers here under injunctions to observe the greatest secrecy, although many of them embodied no new ideas.

No real information of how the equipment was used or the scope of the work was forthcoming, especially in regard to the radio intelligence work. This phase of communication was always kept from general discussion in our own army, even after we had been in the war for a long time. It was considered that the less the enemy knew of our activities, the less preventative measures he would take against them. Few, if any, officers or soldiers who were not directly concerned in the intelligence work were aware of the fact that much of the information that guided their operations had been obtained by the Radio Section. The only other sources of information comparable with it were the prisoners captured from the enemy. By the same token, the less our men knew of our work the less they could tell should they fall into the hands of the Germans. If the location of a listening station became known its effectiveness was immediately destroyed by the counter measures taken against it, so that many a doughboy noted the strange equipment in a dugout in his sector without knowing its purpose.

The Germans are generally given credit for first discovering the possibilities of these ground listening stations and the precautions they took at the outset to keep the men assigned to this duty from coming in contact with other soldiers and discussing their work, are interesting. They were given extra pay, their meals were brought to them and they were pampered in every way and they were evidently the most exclusive branch of service in the German army. Once the work became known to the Allies, though, this exceptional treatment was discontinued and these "cellar detectives" were treated like the rest of their army.

In the early Spring of 1917, a French delegation headed by Dr. Abraham, the well known scientist was sent over to the United States to demonstrate the wireless and T. P. S. equipment used by the French Army, but the information was treated more as of scientific interest than as vital for general distribution among those who would later be called upon to use it in the field or to guide them in the manufacture of similar equipment in this country. Specimens of the apparatus in use by the French Army were furnished, which were to be used to guide the development and production in this country of equivalent material so that the U. S. Army could later be entirely independent of European supply. The fact that this desirable and, if the war had continued, possibly essential condition was not attained has already been told. The French Government had promised, meanwhile, to provide all the necessary radio equipment for the American troops until such time as production could commence in the United States, and this they were able to do until the drive of the Germans in March, 1918, when the rapid advance toward Paris resulted in a loss to the French of enormous reserve supplies of radio equipment. They were brought face to face with the urgent necessity of re-equipping their own men without considering ours. Added to that, it was these dark days of the war that brought on the influx of American troops at the rate of ten thousand a day—figures entirely beyond the calculations of the French when they agreed to furnish us the necessary radio equipment. Our own material had not been satisfactorily developed or produced in quantities in the United States and we were unable to look there for relief. Of those who watched the progress of the battles around Chateau Thierry, none were more harassed by anxiety than the officers who were concerned in the problem of obtaining radio equipment for our troops.

With the turning back of the Huns on their tracks toward Germany and the removal of the threat to Paris, where most of the radio factories of France are located, the French Army authorities regained confidence and the supply of wireless equipment was resumed. The British were never able to furnish us any amount of apparatus

and it was inadvisable to use different types, which would complicate the supply and maintenance of equipment as well as the training of the personnel.

Tours of duty with both the French and British Armies had indicated to Lt. Col. Krumm that the French equipment was equal to the British and more suited to the methods of the American Army, so that no concern was felt as long as it was possible for the French Army to provide us with radio material. Nor was there any doubt as to the ability of our men to handle the apparatus; the standard of operators of this country is as high as that of any of the Allies, and events proved our faith in our men to be well founded.

It might be well at this point to acknowledge the debt this country owes the amateur radio operator for the work he did in the Army. In his position as Chief Radio Inspector, Bureau of Navigation, before the war, Colonel Krumm had looked upon the amateur radio man somewhat as an omnipresent American evil, like mosquitos. But it was these amateurs who were among the first to respond as volunteers for the Signal Corps, and his respect for them increased immediately and it has never since abated. Subsequently, their excellent work in the field under the most discouraging circumstances, under the most trying and uncomfortable conditions, has earned them a place in history. Too generous appreciation cannot be recorded of those who fostered and cultivated this invaluable source of supply of American radio operators, probably without ever realizing just how well they had planted the seed. Allied officers often spoke of this phase of our personnel supply and regretted the interest in radio matters had never existed in amateurs of their countries, as it had in ours.

The value of real enthusiasm for his work—an outstanding characteristic of most amateurs—was particularly shown in the radio intercept stations. The ideal operator for this work is one who never for one instant ceased to hunt for enemy stations with his receiver. He must record a jumble of mixed letter groups which to him mean nothing. A mistake of one letter in a three letter group will probably throw the decoders entirely off the true meaning of the message. He must record the wave length used and get all the prefixes so that the stations communicating can be determined. But above all he must instinctively note every personal characteristic of the senders "fist," or transmitting methods. Many a German organization has been traced all along the front by some peculiarity of a radio operator attached to it, who did not realize the necessity of absolute uniformity in sending. To detect these things the intercepting operator must never let down the intensity of his interest. The enthusiasm of the amateur for his work was one of his biggest assets.

When we entered the war the U. S. Army had in use only two types of wireless equipment; neither of these sets could be used in France.

Officers of the line did not take radio seriously. One whose unit had been isolated in the Argonne sent back this wireless message: "All communication cut off. How shall I keep in touch with you?"

***The various fields of usefulness found for wireless were practically a sealed book to the American Army; the gigantic undertaking of training** and equipping the personnel for this work represents one of the nation's greatest achievements.*

Unfortunately for the Army, a very large proportion of the commercial and amateur operators joined the Navy at an early date, so that the supply of expert men available was soon exhausted, and the many additional men required had to be trained. This branch of our activities holds many points of interest and will be covered more fully at another time.

Officers of our Allies often indicated their belief that our men were notably successful because they were fresh in the work, but they expected when we had been in the war as long as they had, that we would also lose our enthusiasm and effectiveness. This no doubt was true to some extent, and it applied in a minor way to all branches of the service, but on the whole the American Army can look back on the work of its radio personnel with genuine and particular satisfaction.

When a man has had three or four years of operating under constant shell fire all the glamour of war disappears and the daily communication duty becomes a grind. This view was illustrated one day when Colonel Krumm visited one of the French artillery receiving stations to which range corrections from airplanes were wirelessed. As the visitor was regretting that his limited knowledge of French prevented him from questioning the operator, the latter in good English informed the American officer that he knew him in New York. The operator then explained that he was a New York boy of French parentage and had joined the French Army three years before, resigning his position as a Marconi operator on a ship sailing out of his home port. Commercial operating had never been like his present job, he readily admitted, and added that he was "fed up" with the war thing. This was in the Champagne country during the disheartening days of the Fall of 1917. Our men never experienced the depressing effect of the discouraging battles as did the Allied operators—so it is fair to assume that the Allied officers were right in their estimate of American effectiveness.

This listening station in the Vosges is typical of those maintained so secretly by American wireless men that doughboys in the same sector never learned the purpose of the strange equipment

Captain Taylor joined the A. E. F. in December, 1917, about the same time as the first detachment of about seventy expert operators arrived. The Radio Section (Intelligence) of the Radio Division was then organized. The accompanying chart shows the scope of this organization and the duties of the Radio divisions on the day the armistice was signed. On December 8th, 1917, the first radio intelligence stations, intercept and gonio, were established in a French sector. It was considered advisable to operate some intelligence stations in the French position so our men, both operators and decoders, would have an opportunity to work under actual fighting conditions. The radio intercept and goniometric stations were there-

CHIEF SIGNAL OFFICER AMERICAN E. F.

RADIO DIVISION
Lieut. Col. L. R. Krumm
OFFICER IN CHARGE

CO-ORDINATION SECTION
Captain Willis H. Taylor, Jr.

Function:

Co-ordinates work of other sections as follows:

Maintains liaison with Division of Research and Inspection and Radio Div. at Washington.

Checks all requisitions to Supplies Division.

Supervises and co-ordinates radio requirements of Tank Corps, Artillery, Sound Ranging and other arms of service.

Supervises development of such equipment as radio tractors, trailers and other radio auxiliaries as necessity arises.

Formulates radio bulletins covering field instructions for the operation and maintenance of radio equipment and auxiliaries.

AIR SERVICE SECTION
Major F. N. Shumaker.

Function:

Installation and maintenance of radio equipment on airplanes.

Supervision of operations of independent squadrons.

Prepares originals and checks Air Service requisitions for radio equipment to be checked by Co-Ordination Section.

Indicates Air Service personnel needs to Correspondence and Personnel Section.

Maintains liaison with the Air Service and in general co-ordinates the work of that service and furnishes information as to the needs of the Air Service.

Prepares technical instructions for guidance Air Service Radio Personnel.

OPERATIONS. TECHNICAL SUPERVISION OF RADIO OPERATIONS IN THE FIELD

ASSISTANT CHIEF SIGNAL OFFICER

G. H. Q. Radio Section Signal Corps—3 officers and 75 men. Operation of long wave intercept stations at G. H. Q. Information collected for Radio Intelligence Sec. G. S. G-2.

TRAINING SECTION
Captain Harlowe Hardinge, Hq. 2nd A. I. C.

Function:

Supervises the training of the radio personnel of the army other than the Signal Corps for which the Signal Corps is required. This includes Air Service, Tank Corps and Artillery personnel.

The training of the Air Service personnel covers squadron radio officers, pilots, observers, radio mechanics and operators and the special personnel of the bombing squadrons involving direction-finding and navigating radio equipment.

All the above work is covered at several fields in France and England.

Training of the Tank Corps signalling personnel, the most important part of which is radio training. This is carried on at the main tank center.

Various officers are sent from this section to different artillery training areas as requested for the establishment of radio schools and the training of artillery radio personnel.

Indicates to the Cor. & Pers. Sec. the number and qualifications of the Air Service personnel which has completed training and which is available for assignment to active duty.

Submits necessary requisitions for equipment and Air Service facilities to accomplish the above training.

CORRESPONDENCE AND PERSONNEL SECTION
Lieut. Ray Rice

Function:

Compiles monthly, weekly and other reports.

Supervises office, personnel correspondence and files.

Radio Division, Signal Corps and Air Service personnel, records and matters.

Requests necessary orders covering movements of Signal Corps and Air Service radio personnel and maintains the necessary records covering personnel.

OFFICER IN CHARGE, RADIO SECTION BASE
Major Robert Loghry

Function:

The work of this Base is accomplished by utilizing the authorized organization of the Army Radio Section with such extra personnel attached thereto as is necessary. These duties include the operation of the intelligence system of the different armies as required by assigning radio detachments to each army under the command of necessary officers.

The assignment of call letters and wave lengths to the different armies.

Technical co-ordination of the radio operations of the different armies.

Maintenance of a store room where radio equipment is overhauled and repaired.

Submits all reports, technical request and requisitions to the Chief Signal officer through the A. C. S. O., G. H. Q.

Supervision and co-ordination of the radio work of the independent Air Service force.

Trains replacement personnel for the radio detachments, maintenance of a school and operation of practice stations.

Has available field instructors capable of teaching troops the use of radio and T. P. S. equipment.

Supervision of field tests of radio equipment under development.

CHIEF SIGNAL OFFICER OF AN ARMY

RADIO SECTION DETACHMENT
Function:

Operation of the radio intelligence stations of an army consisting of control, intercept, gonio and listening stations.

Supervisory work of the radio activities in the army as desired by the Chief Signal Officer of each army.

CHIEF SIGNAL OFFICER OF AN ARMY

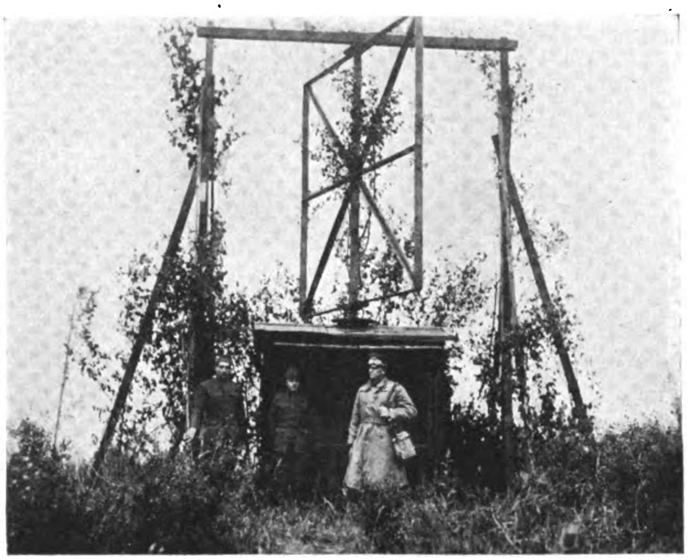
RADIO SECTION DETACHMENT
Function:

Operation of the radio intelligence stations of an army consisting of control, intercept, gonio and listening stations.

Supervisory work of the radio activities in the army as desired by the Chief Signal Officer of each army.

fore established to the west of Verdun in territory held by the French and covered by their own radio intelligence system. Our stations were understood to be practice installations and every assistance was given us by the French to become acquainted with the practical phases of the work. Thus we were pleased and flattered when, within a short time, we received a request from them to furnish copies of all the messages and goniometric readings recorded; subsequently we had reason to know that they were exceedingly grateful for our assistance.

With the entrance of our troops into the line came the real test of our radio communication. The training or practice which we carried on under conditions which appeared to be exactly those of actual warfare seemed advantageous; but how fallacious this idea was quickly developed in the operations. The first troops to go into the line had been given several months' training; the



A camouflaged gonio, or wireless compass station of a type operated by the Radio Section (Intelligence) Signal Corps, in France

officers had been afforded an opportunity to visit sectors held by the French and English troops and had been in the atmosphere of war for several months before actually participating in it. Later, when our soldiers were arriving at the rate of two divisions a week and were sent into action almost immediately, many of the signaling troops were unfamiliar with the radio equipment and had only a sketchy knowledge of their proper function in the communication system. Troops which went into the line with the British Army, after training with French sets, were provided with British radio equipments. Because of the delay in producing equipment in the United States few of the radio personnel sent over to the A. E. F. were properly trained or prepared to take up their work, in fact, their first knowledge of duties and the equipment which they would use was gained after their arrival in France. This made radio training one of the hardest problems. Yet in spite of the many handicaps nearly all acquitted themselves with credit and the difficulties overcome by the different radio companies of the Signal Corps will make interesting reading.

Considering the short period of training given our signalmen the results were magnificent; possibly the principal factor in restricting the usefulness of our radio was the ignorance of many American officers as to its limitations and possibilities. The reluctance of our officers to code message was the greatest single handicap. Operators were absolutely forbidden to transmit anything "in the clear" and all messages were required to be handed them in code. So difficult was the enforcing of this requirement that the probable future practice in handling these messages will be to have them coded by the Signal Corps personnel. The failure by line officers to take radio seriously is illustrated by an episode. said to have occurred in the Argonne. An officer commanding a unit which had become isolated sent back the following radio message: "All communication cut off. How shall I keep in touch with you."

Earlier in the article one class of radio operations was referred to as embracing offensive activities, to indicate the use of the wireless telephone and telegraph as a means of communication between the different units and branches of service of an army. This not only includes stations at different infantry battalion and regimental headquarters, brigade, division, corps and army headquarters, and similar units, but also the special radio services of the air service, the tank corps, artillery sound ranging by the engineer corps, and the meteorological service. All have highly specialized requirements, especially the air service.

At the beginning of the war the air service was part of the Signal Corps, which is the communication branch of the army. At that time the wireless communications of the air service were supervised by its own radio division as part of the Signal Corps. Later, when the air service was separated from the Signal Corps and established as a separate service, its radio organization was continued. It was found advisable, however, to centralize the supervision of the radio of the air service in the Signal Corps, and about a month before the signing of the armistice this work was taken over by the radio division of the Signal Corps, so that all radio operations of the army properly came under the supervision of the Chief Signal Officer, A. E. F. Radio equipment for the airplanes engaged in war operations must be governed by the peculiar requirements and limitations of the flying craft, but the major portion of their work is with ground stations. Radio communications between planes in flight and from the ground to the planes was never reliably accomplished, in fact, in the war operations of the air service in France. Radio telephonic communication between airplanes—the goal of the air service of every army and the essential requirement if squadrons or larger bodies of planes are to act as a unit—is a subject which was given preferred attention in the United States. Various articles have been written indicating results achieved in the development of radio equipment for communication between and to airplanes from the ground. The sets developed in this country were received shortly before the armistice; they were being tested out and personnel was being trained when hostilities ended. But the radio telephone was never used by our air service in actual combat.

In the so-called artillery reglage work where the airplane observer supplies batteries and groups of artillery with information indicating the accuracy of their shell fire and the correction necessary to obtain the greatest results, our airplanes were probably as effective as those of any other nation. In this wireless work they used the French spark sets, a very simple and light equipment, utilizing a wind-driven generator mounted on the fuselage with the rotary gap on the generator shaft. A trailing single wire antenna was used.

Airplanes were also used for reconnaissance, supplying information by radio to unit commanders regarding the activities of the enemy, and also in many cases the position of our own line. It must be remembered that in mobile warfare, calling for rapid advances such as marked the last part of the war, many of the units were located in woods or other positions which the commanders themselves were unable to recognize. Airplanes thus became the most accurate source of information as to the location of the advancing lines.

Tank radio was also one of the most interesting and difficult questions which confronted American research experts. No wireless equipment had been devised which

would operate from a moving tank. In the British Army the tanks merely acted as transports for the set; it was the practice to drop the set from the signaling tank, establishing it in some protected and suitable place as near the front as possible. The French had experimented with a set using a trailing antenna, but it was found to be unsatisfactory and as far as known never was used in action.

A large antenna cannot be used on a moving tank; it must be small, easily erected and removed. An undamped wave tank set was developed in the A. E. F., so constructed that the radiated wave length was entirely independent of any change in the antenna, which was of the umbrella type consisting of a short pole projecting a few feet above the tank with ribs that could be spread as desired. A sample equipment had been sent back to the United States before the armistice, but had not been put in production and supplied us in time for use. The possibilities of this set cannot be over-estimated, as the mobility of the tanks makes a reliable means of communication absolutely necessary; with an efficient wireless installation they could not only have communicated with their post of command, but with the airplanes working in conjunction with them.

Artillery receiving stations work with reglage airplanes controlling their batteries. Sound-ranging receiving stations were provided to note the radio activities of enemy airplanes, the prelude to their artillery activities. The wireless method was also used in communicating meteorological data, of the utmost importance in the regulation of artillery fire and airplane operations. Weather and meteorological information was sent out approximately every four hours. Spark equipment using approximately the same wave length and spark characteristics as the airplane stations were used for this purpose.

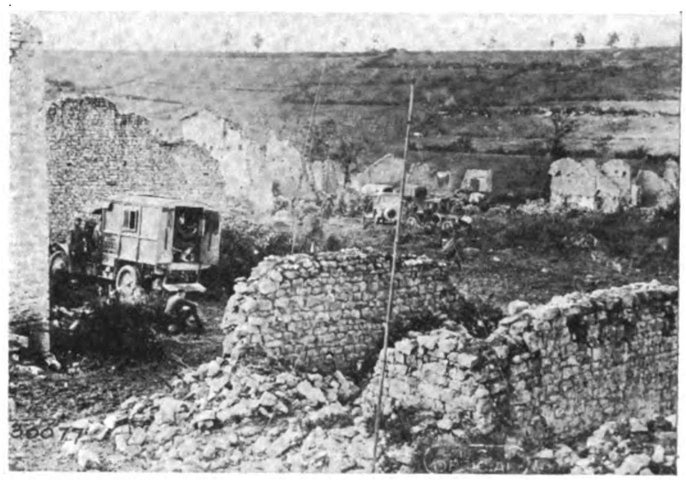
The personnel necessary for all these special radio activities required highly specialized training and this was accomplished as well as time and facilities allowed at many points in France and England. A large school was established at the Air Service training center at Tours, where observation officers were trained in the use of their radio equipment and radio operators and mechanics were developed in large numbers. Captain Harlowe Hardinge, a trained engineer, who had been one of New York's most enthusiastic amateurs before the war, was in charge of the radio school at Tours and the excellent results attained there are largely due to his ability. Other training centers were established for instruction in artillery fire control by wireless, tank radio, and in England a school was to be conducted for the instruction of personnel for the operation of direction-finding equipment, wireless apparatus which enables bombing planes to attain their objective at night and return to their home field.

The debt this country owes to the amateur radio operator in the Army is acknowledged in this article.

These civilians were the first to respond as volunteers and their excellent work in the field under the most discouraging circumstances has earned them a place in history.

Allied officers often spoke of this source of personnel supply and regretted the lack of interest in amateur work in their countries.

The supply of radio apparatus had its special problems. This was an undertaking which necessitated the most careful compilation of advance requirements, so that the ever increasing and overwhelming numbers of American troops might be promptly supplied with the proper radio equipment which would enable them to take their place in the line without delay. To this end all of the production facilities of the French operated in conjunction with the excellent general supply system of the Signal Corps. It should be appreciated that the French were practically unprepared to manufacture radio equipment in quantities sufficient to meet the needs of the French Army, yet the problem was enormously complicated by the wholly unexpected arrival of an immense American Army in an incredibly short period. Considerable readjustment of their manufacturing plans was required to meet this demand. General Ferrie, Chief of the French Military Radio Telegraphic Service, and his staff will always be remembered in this connection for their untiring efforts and co-operation in this difficult task.



Divisional Fiat tractor radio station in operation within ruins to avoid detection

While it was the policy of the Signal Corps not to manufacture any radio telegraphic or telephonic apparatus in France, the equipment purchased had to undergo rigid inspection before acceptance from the French Government. This work required men familiar with all phases of manufacture. Well equipped laboratories were established to provide for this important function, and to conduct the research work necessary in the development and solution of immediate problems. Here, too, was centralized that necessary research which served as the basis of intelligent constructive suggestions forwarded to the United States. In this work the Signal Corps was extremely fortunate to have Major E. H. Armstrong as an advisor on all technical matters. To him may be credited many achievements in connection with the constantly arising difficulties with apparatus and its maintenance, to say nothing of the radio development carried on by him in his laboratory.

The reader has now been given an outline of the great field of endeavor covered by radio men in the A. E. F. That these various activities required specialized methods and equipment is evident to laymen as well as those actively engaged in the art. The succeeding articles of this series will cover each subject in more detail, describe some of the French apparatus used and record some of the many experiences that befell our radio men in the A. E. F. while accomplishing results which should ever remain a source of pride to the whole American people.

(To be continued.)

Lowenstein's Quenched Gap

VARIOUS forms of quenched gap have been proposed heretofore, but they have one disadvantage. If any of the component gap elements have to be removed for repair or replacement, it cannot be effected without disturbing other gap elements in the series, and practically taking apart and reassembling the complete gap structure. Such a procedure involves loss of considerable time and it also involves expert work which may not be convenient.

This and other defects inherent in quenched gaps are obviated in the improved construction devised by F. Lowenstein, in which the component gap elements, which are broadly of the tubular type, are so assembled and mounted that any spark gap element or unit is individually removable and replacable practically in an instant, without disturbing any other unit of the complete gap, and without the exercise of any special skill on the part of an operator. The number of spark gap elements in the series may be readily varied at will to adjust the total spark length in response to working requirements.

on the outer and inner shells respectively. This form of joint between the insulating rings and the shells or electrodes insures that the spark gap space is sealed substantially air tight, which is desirable. The seal is permanent even when the electrodes become heated and expand; for in the event of such expansion the electrodes press against the ring surfaces 18 and 19 which are similarly located as regards resistance offered to the radial thrust of the shell expansion, and the tightness of the joints therefore maintained.

Another advantage secured by this construction is that the clamping pressure of terminal rings 14 and collars 21 is exerted in a direction parallel to the gap surfaces, so that the width of the gap is independent of the clamping pressure. Where gap electrodes are held by clamping means exerting pressure transversely of the gap surfaces, the width of the gap and hence the performance of the sending system, varies with the degree of clamping pressure.

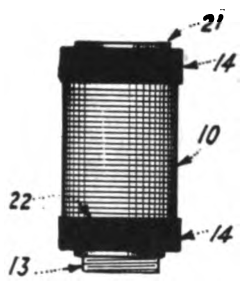


Figure 1

Figure 3

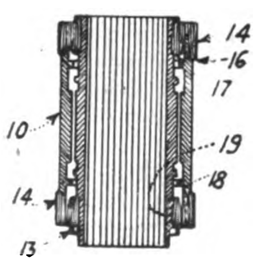


Figure 2

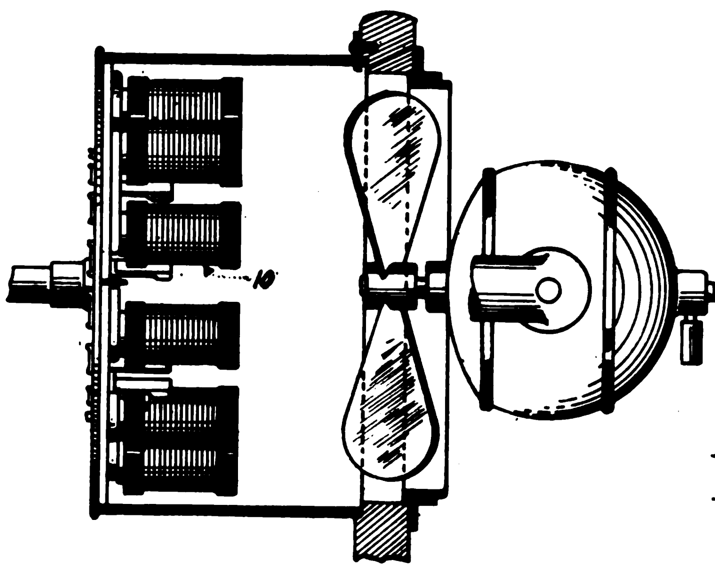


Figure 4

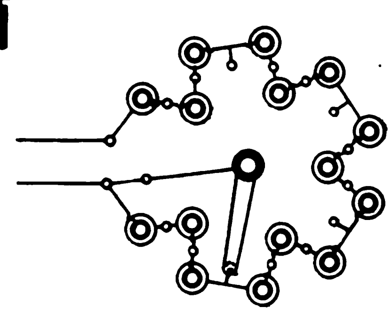


Figure 5

Various parts and the complete assembly of the quenched spark gap with cooling fan in place

Referring to figures 1, 2 and 3, the spark gap device comprises an outer cylindrical shell 10, within which is an inner shell 11 which in this instance projects unequal distances beyond the ends of the outer shell, the projecting portions being threaded as at 12 and 13. These shells or electrodes are made of copper and are spaced apart and insulated from each other by insulating rings 14, each of which is slotted or channeled along one side to accommodate an end of the outer shell or sleeve. Each insulating ring is thus divided into two connected parts, 16 and 17, whose parallel inner faces 18 and 19 engage the convex surfaces of the outer and inner shells, respectively. The parts 17 of the insulating rings extend between and space apart the shells to form the spark gap. The outer faces 20 may be slightly sloped or beveled as shown. The insulating rings may be locked in place by threaded collars 21 which are adapted to be turned down on threaded portions 12 and 13 of the inner shell into locking abutment with the rings. When the rings are in proper position they abut against shoulders 22 and 23

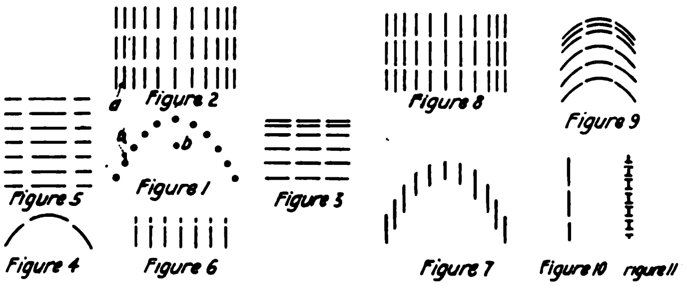
As shown, the central or intermediate portions 24 of the electrodes are formed in such a way that the annular spark gap spaced is narrower at this locality than toward the ends; and it is at this locality that the sparks actually pass between the electrodes. Annular circumferential ribs 10^a and 11^a formed on the electrodes 10 and 11, respectively, project into the wider portions of the gap space and are in staggered arrangement. These ribs act as baffles to prevent particles of metal from being "spattered" or otherwise transferred from the spark to the insulating surfaces at the ends of the gap, thus preventing deposit of metal on the surfaces and consequent destruction of their insulating properties.

The outer or convex surface 27 of the outer electrode shell and the inner or concave surface 28 of the inner shell are longitudinally grooved or fluted to provide a large radiation surface for rapidly dissipating the heat from the spark. In practice, when the spark gap is in operation, both these surfaces are cooled by a fan. Figure 4 shows the mounting of the gap and cooling fan. Figure 5 indicates the circuit for cutting in and out the gaps.

Marconi and Franklin's Directive Radio System

PARABOLIC reflectors to confine the radiated wave in a wireless system within a limited area have been devised by G. Marconi and C. S. Franklin. It is understood that these reflectors work extremely well and have been applied in a practical way for transmission at very short wave lengths.

The reflector is constructed of two or more sets of



Detailed drawings of the newly devised parabolic reflectors

rods—which term includes strips and wires—arranged on a parabolic surface around the transmitting or receiving aerial as a focus, each rod being tuned to the aerial and the rods of the different sets being preferably in line with each other. By this means, the efficiency and effect of the reflector are very largely increased. For example, by making the reflector of three sets of rods arranged on a parabolic surface and having a focal distance of one-quarter wave length, the range may be increased from 400 per cent to 500 per cent as against 80 per cent obtained with the simple reflectors before known.

The construction in detail follows: On a parabolic surface surrounding a transmitter or receiver and in the correct direction having regard to the polarization of the transmitted waves, is arranged a number of long wires which are divided up into elements each in tune with the transmitter. The length of each element is preferably about half a wave length, but may be made either greater or less than this by inserting in it either a condenser or an inductance. The adjacent ends of these elements may be insulated from each other or joined by inductance coils or condensers, the controlling factor being correct tuning with the aerial. That means that each element when in its working position in the reflector is in tune with the aerial.

In practice, it has been found that some of the elements may be removed slightly from the true parabolic surface provided that those elements of the reflector which are nearer the focus than they would be if on the parabolic surface are tuned to a rather longer wave, and those elements which are farther, to a rather shorter wave. For very short waves, no earth connections are required or desirable, but for longer waves, it is an advantage to earth the aerial and the lower elements of the reflector.

Very good results can be obtained by arranging the elements on a cylindrical parabolic surface, but better results can be obtained by arranging them on a true paraboloid, particularly when using a reflector having a focal length equal to three-quarter wave length or more. In the drawings, figure 1 is a plan, figure 2 a rear view and figure 3 a side view of a reflector constructed in accordance with this invention.

Figures 7, 8 and 9 are plan view, rear view and side view respectively, of a third form of reflector.

Figures 10 and 11 are diagrammatic detail views each illustrating a single set of rods or wire reflector elements of which the reflectors may be built up.

The reflector illustrated in figures 1, 2 and 3 has three sets of parallel rods (a) arranged on a cylindrical parabolic surface with an aerial or antenna (b) at the focus. This arrangement is for concentrating vertically polarized waves in the horizontal direction.

In the arrangement shown in figures 4, 5 and 6, the individual reflector members are placed in parallel planes which are spaced apart vertically instead of being spaced horizontally as in figures 1, 2 and 3. The object of this arrangement is to concentrate horizontally polarized waves in the horizontal direction. In the arrangement of figures 7, 8 and 9, the reflector has three sets of parallel rods arranged on a true parabolic instead of a cylindrical parabola; this will concentrate both vertically and horizontally polarized waves in the horizontal direction.

These figures illustrate reflectors made with three sets of parallel rods or, stated otherwise, reflectors made up of a number of wires each divided into three elements, each element being in tune with the transmitted or received wave. As illustrated, each of these elements should be nearly half a wave length long; alternately each of these wires may be divided up into a larger number of elements connected together by condensers.

Figure 10 shows one wire divided into three elements each in tune with the desired wave. Figure 11 shows one wire divided into a number of shorter elements connected together by condensers. The capacity of each condenser must be such that if joined in circuit with the inductance of the wire joining it to the next condenser, it would form a circuit in tune with the desired wave.

Reducing the Dielectric Stress of Condensers

IT is a well known fact that high potential condensers, such as for example, the Leyden jar, are usually subject to break-down near the edges of the conducting armatures. The dielectric stress centers at these edges, although at other points between the plates, the stress may be nearly uniform. This concentration of pressure is evidenced by minute discharges or "brush" that pass from the coating to the dielectric. This playing of the brush over the surface of the dielectric causes local heating in the latter, due to its poor conductivity.

David T. May has devised a method whereby the localization of this stress is materially minimized. In figure 1 is shown a condenser of the Leyden jar type having inner and outer conducting plates. Extending from the edges of these conducting plates 8 and 8′ are two metallic caps, 9 and 9′ which are suitably attached to the dielectric but are electrically separated from the conducting plates by air gaps, 10, 10′, 11 and 11′, the latter pair being the

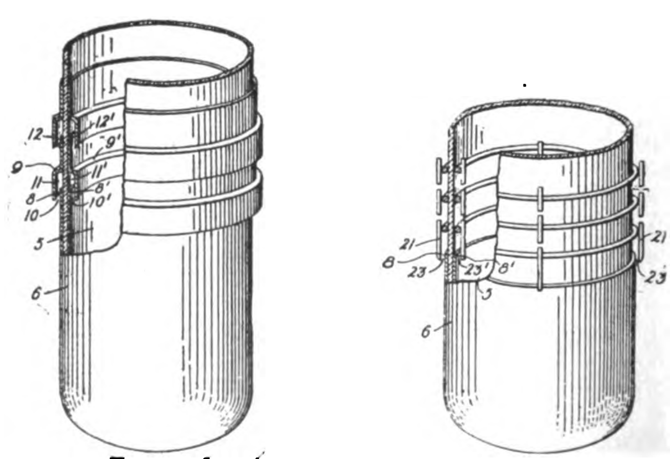


FIGURE 1 FIGURE 2

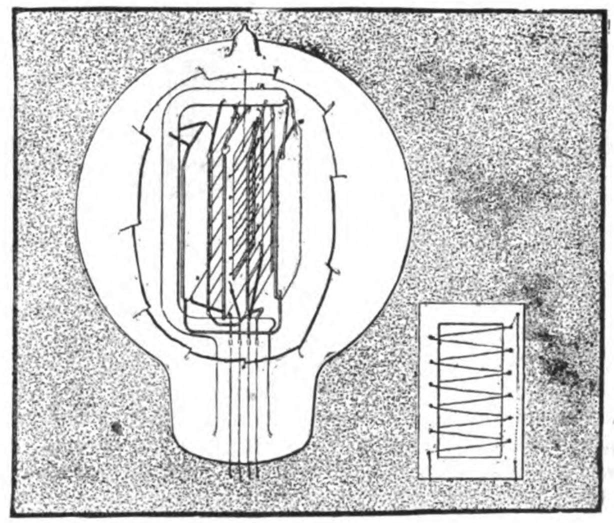
Condensers of the Leyden jar type

greater. When a condenser equipped with these caps is connected to a source of high potential, it is found that the brush no longer plays over the surface of the dielectric, but that sparks pass across the gaps 10 and 10′. In this way the stress at the edges of the plates 5 and 6 is considerably relieved and the interposition of the air gaps 10 and 10′ in the path of the current cuts it down to a point where the brush is not produced to an injurious extent at the edges 12 and 12′ of the caps. If it is desired, a plurality of caps may be employed, each one being separated from the preceding one by air gaps of suitable dimensions. It is preferable that the gaps 10 and 10′ should be smaller than the gaps 11 and 11′ because sparking across the shorter pair of gaps will be to those portions of the metallic caps from which the heat may be radiated away most readily without injuring the dielectric.

In figure 2 is shown a modification where metallic rings are sprung against the walls of the jar instead of the metallic caps. Each of these rings carry several wire pieces which form air gaps with the metallic conducting plates of the condenser. Harmless sparking will occur across the gaps 23, 23′ upon charging the condenser to a high potential and the injurious brush is thereby eliminated.

Warping of Filaments Prevented

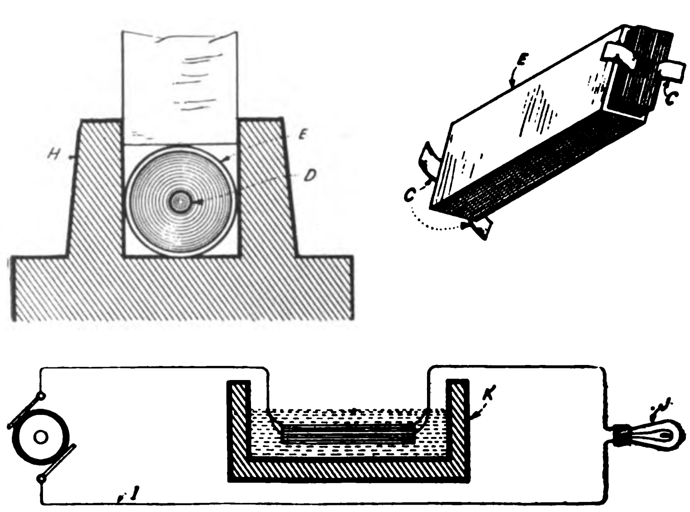
TROUBLE has been experienced in the past in connection with the employment of filaments in vacuum tubes due to the fact that the cathode filament when heated becomes elongated and unless some means is adopted for overcoming it, a warping of the filament will occur. Inasmuch as the energy output of a thermionic device of this sort is dependent among other things, upon the distance between the cathode filament and the other electrode members, it follows that any warping of the filament toward or away from the grid member for example, will cause an alteration in the constants of the tube. It has in the past been proposed where filaments of loop form has been used, to remedy this defect by providing a spring support for the apex, thus placing the filament under a certain amount of tension and taking up an expansion of the loop in such a way as to keep the loop in its initial plane. Such tension on the filament has been found, however, to be undesirable in some instances, as tending to decrease the life of the filament.


Nicolson construction of the filament on a supporting member

Alexander McLean Nicolson has devised a method of maintaining the filament in its initial plane, which consists in entwining or threading the filament on a supporting member so that it will be held by the said support at several points distributed along its length. While this arrangement does not, of course, prevent the linear expansion of the filament, it minimizes the effect of such expansion in that it prevents the cumulative warping effect and confines the warping to several relatively short sections, the result being that the total effective lateral displacement of the filament due to warping is kept within reasonable bounds.

Eliminating Moisture from Paper Condensers

AN improved method of overcoming difficulties encountered in the impregnation and the elimination of moisture from paper condensers has been devised by William C. Brinton. Ordinarily it is desirable to dry the paper used in paper condensers thoroughly in order that the moisture may be excluded, and this drying process oftentimes materially weakens the paper mechanically. After drying the paper and forming the condenser, it is necessary to impregnate the whole, quite some moisture being absorbed during the process of assembly due to handling.


Showing construction of paper condensers to eliminate moisture

In the method devised by Mr. Brinton, the difficulties are overcome by arranging the dielectric or conducting material (the paper preferably not having been preliminarily dried) winding the strip on a mandrel cylindrical in shape, withdrawing the mandrel, inserting the condenser into a tubular casing of drawn steel, and without intermittent treatment, subjecting the whole to pressure to convert the cylindrical condenser into a condenser of oblong shape and of considerably reduced volume. The condenser is then immersed in a body of dielectric impregnating liquid, such as wax or olive oil, preferably heated, and simultanteously an electric alternating current is passed through the condenser. This results in the conversion of the moisture into steam at a high pressure, the escape of the steam, and the replacement of the displaced water by impregnating dielectric liquid.

A Summer on the Great Lakes

The Third of a Series of Impressions of a Novice in Commercial Wireless Operating

By Julian K. Henney

III—Life on the Deep Blue Water

AFTER leaving Buffalo the Juniata followed the shore line of Lake Erie to Cleveland, arriving there the next morning. The clear sky, the blue water, and the fresh air made a fervent appeal to all of us, for we had been caged up on board the steamer all day long.

A few minutes after we left, the City of Detroit III slipped out of her berth on her way to Detroit, and at eight o'clock the Seeandbee started back to Cleveland. We had company on Lake Erie that night, but the wireless signals were indecipherable through the static. Shortly before arriving in Cleveland we tried to get into communication with WCX there, but atmospheric electricity was roaring in with all the sharpness and continuity of a tropical thunder shower. Then, and often during the summer, Watson and I thought of inventing a static preventer, but at each attempt we decided that it was slightly beyond the scope of our technical knowledge. Instead we devised methods of keeping the sparks from jumping into the receivers, and making blue flames all around the galena detector crystal. We hadn't fancied the carborundum supplied with the tuner which we had hooked from the Tionesta, so we had substituted galena from a small supply which I happened to have along. Needless to say, the crashes of "X'S" knocked the galena all over the place, and it was quite impossible to work Cleveland.

At six o'clock, we were startled by the ear-splitting scream of the Cleveland fog horn howling outside our porthole. That is some blast! I firmly believe that if all the unholy, unearthly and fiendishly disconcerting noises in the world were concentrated in one the Cleveland siren would have it beat. I much prefer to risk the perils of the fog unaided.

A few minutes later the black shape of the Western States crept past us in the early morning fog, making her way to the splendid new Ninth Street Pier; the Juniata poked her nose through the murkiness toward the deserted old coal docks where our passengers were scheduled to land. We tied up beside a coal barge and several camouflaged Shipping Board boats.

As we left, an hour and a half later, one of the camouflaged affairs appeared over the port bow with disconcerting suddenness. The sensation was an eerie one; in fact, often during the summer I watched those painted ships approach, never knowing whether the vessel was going sideways, forward—or straight up. In foggy weather it was almost impossible to see them at all.

In Buffalo we watched high-speed riveters put on the plates; in Cleveland we saw many of the new ships being loaded to their depth of eighteen feet; in Detroit we heard their radio equipments being tested, and in all of the northern ports we came across them at odd intervals. The continuous string of numbers which zigged off their wireless aerials by the hour was enough to drive a man crazy; they sent a message in plain United States, and I often wondered if the operators thought, dreamed, and ate numbers.

At noon of the second day we passed Colchester Light at the entrance to the Detroit river. The sun had chased away the last of the murky atmosphere, and the warmth felt good after the damp fog of the early morning.

Noon was one of the turning points of the day. It meant a change of watch for nearly everyone—and for half the crew it was a Godsend. In cold weather neither the decks, the pilot house, or the radio cabin were pleasant places, and a nice warm meal and bunk looked pretty good. To those of us who were compelled to climb out into rain or sleet, or the dampness of Lake Superior fog, the watch changing meant something. Midnight was also an important time of day, for at this hour the night tricks changed and the first mate starts his "six on" while the Second Officer and the Old Man slept. There was always a lunch in the mess rooms, warm coffee in the galley and, occasionally, some fruit.

That first noon hour on board the Juniata was indeed an important event. As usual, I was hungry. Sitting on a hard chair with the receivers over one's ears is not supposed to be a hunger provoking job, but Snell and I were always ready to eat when the time came. Answering the questions of all the women on board and half the men, sending an occasional message, constituted our principal duties. The queries were monotonously alike. "What is that wire for? I thought this was wireless," or, "That long rope hanging over the back end with the whirligig on it—is that your aerial?" Or a lady passenger would use up a half-dozen blanks writing a message to the kids, and then nearly faint when you suggested the rates—all of these occurrences somehow were hunger-provoking. And that first day was no exception.

Snell and I ate in the First Officer's Mess, along with the two mates, three engineers and the Purser's Assistant. The mess room was located about a dozen steps from the radio cabin and, with no occasion for delay, I was the first to enter the small room. As I sat down I felt that this was to be the supreme test. I awaited the appearance of the waiter with some apprehension and considerable anxiety. Snell and I had decided that we might as well inaugurate the season by asserting our authority from the start. We knew that it would be easier to have our own way from the first, than to wait until we got acquainted. The subjugation of the porters had taken place the night before; we had made them make up our bunks and bring us icewater. Now the campaign on the messroom waiter had to be accomplished without further delay. The performance started with a rush. There was no one in the room to see any possible failure and this rather emboldened me. As the waiter appeared from the galley, a clean towel over his arm, and a hand-

ful of shining implements in his hand, he queried: "Soup?"

"*Well* yes!" said I, with considerable rising emphasis on the latter part of "well." The effect was astonishing.

"Yes suh—yes suh—right away suh!" and Baltimore, the negro, rushed away to the galley with the greatest speed ever attained by any waiter. In a jiffy he was back with a bowl of steaming soup. He placed this in front of me with a most abject look and he kept offering crackers and celery, wiping the implements over and over again, and bowing and scraping so that I feared I would not get the soup down before I choked with suppressed mirth.

That soup was the hottest stuff I had ever tasted. Whether the heat was caused by the galley stove or by the militant seasoning of pepper was more than I was able to ascertain at once. By the time I had succeeded in swallowing several spoonfuls the Second Officer had come in. Bill was a huge fellow, fully six feet tall and wide in proportion; he towered over all the other members of the crew. He was the most feared man on board, and when there was any enforcing of the rules to be carried out, they let Bill do it. His brand of profanity was the choicest and his command of it was liberally attested to by the deckaroons, or common deckhands. When Bill came in and sat down he was puffing like an engine. I supposed he was peeved about something; but I soon discovered that Bill always puffed. Bill had the asthma. He also had a capacity for soup. Before he was ready to demonstrate this the rest of the officers had come in. Conversation began.

Bill pointed to the coffee, "I see they've been scraping the galley floor again," he observed.

The coffee did look a little muddy, and I thought I detected the odor of potato peelings and coal ashes.

But taste or looks did not bother Bill. He gulped the mixture at a swallow and called for more. Then he tackled the soup. Two spoonfuls were down before he looked up, reproachfully, at the Chief.

That officer returned a look of sympathy and understanding. "They tapped the well last night," he shot back.

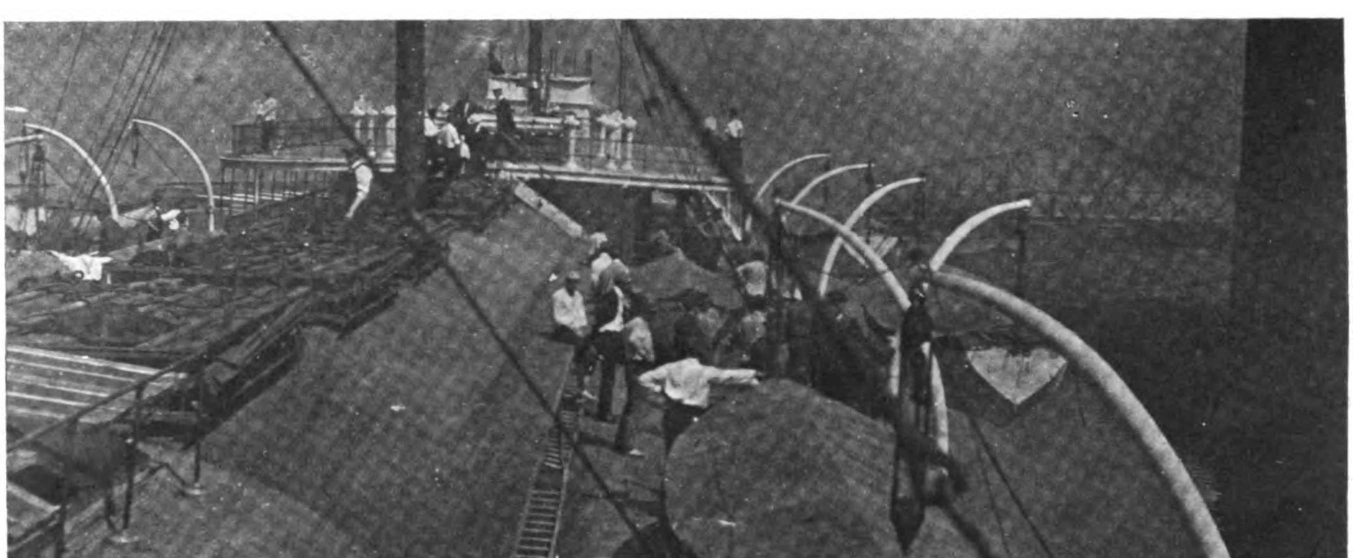
I had already noticed a rim of dark round objects at the edge of the soup. I had thought these pepper; now I wondered if they might be mud. I began to lose interest in the soup. But not Bill; he was gulping it down with all speed. Thoughts of the well—the bottom of the ship—and of the seepage or bilge water which it contained, did not disturb him. By the time Baltimore had brought me the remainder of my dinner, Bill was ready for more soup. It went with the same rapidity and lack of imagination.

Throughout the remainder of the meal the Chief found something wrong with everything, and never hesitated a second about springing any crude joke he happened to think of that might aid to describe the eats. His remarks were liberally punctuated by profane expletives. Finally, the First Officer put a stop to the rumpus.

For several weeks the same performance was repeated at each noon and evening meal. The same kind of food was brought in and the same conversation took place between the Chief and Bill, in all of which the other officers and myself took little part. Later in the season the owner of the line happened to eat with us. After this we had the passenger bill of fare and each man was required to write out and sign what he wanted. This was an occasion for considerable mirth with Bill and the Chief. Neither wanted the other to know what he had ordered, but both were anxious to find out what the others had eaten. The new system livened things up a little and put us on a better basis as regards the rest of the crew.

When traffic was heavy the Purser ate with us. Occasionally, too, he ate with us after a night in the buffet, or when some woman passenger he didn't care for succeeded in getting a seat at the Captain's table. At such times the conversation was still more sordid. The Chief and Bill both knew that Mac's stomach was weak, and his digestion was easily upset so the conversation would start with the usual allusion to the galley floor, to horse meat and to bilge water, when Mac began to lose interest in the food the Chief would remark that the gravy tasted like tobacco. Immediately, the Second Engineer would note acquiesence and point to the galley slave toiling away in the corner of the second officers' mess, a big burly chap whose jaws worked constantly beneath cheeks eternally full of Honest Scrap. Purser Mac at this point of the game would look at Paul with such an appeal in his eyes that Paul would gravely reprimand the engineers and the rest of us who were enjoying the affair.

But to get back to my narrative. After dinner I was off duty and had six hours to use sleeping or loafing, as I chose. I found this a good opportunity to watch the beautiful scenery of the Detroit River. Cottages along the banks were flitting past in a never ending stream; many vessels passed us, and each saluted with the cus-



On the boat deck were the life rafts and bunks for the colored pantrymen; the upper deck was called the "flicker," but no one knew just why


When off duty I had good opportunities to watch the scenery; I alternated my sightseeing with wandering expeditions about the boat

tomary three long and one short blast, signifying that they were glad we were back on the Lakes again after lying idle for the winter. I alternated my sightseeing with wandering expeditions about the boat and soon became acquainted with the Juniata. She was a real vessel—much different from others I had been accustomed to sail on.

Forward on our deck—the salon deck—were the music room and library, both generously furnished with soft chairs and cozy corners where one might read or watch the scenic panorama. In the splendid weather we were having, however, most of the passengers were out on deck, lined up in the lee of the wind in steamer robes and chairs, or parading up and down the promenade deck. Aft of the music room, through a long corridor lined on both sides with parlors, were the social hall and stairs that led to the lower, or berth, deck. The social hall, decorated with well executed mural paintings was followed by the long dining room with its many tables and wide windows that let in all of the light.

The dining room was a beautiful place in the morning. The long rays of the sun came pouring in the port windows and were reflected from the polished floor and from the mirrors at the ends of the room. The mahogany of the chairs, their soft red plush bottoms, the white linen and shining service were something to remember, and I thought that morning that eight dollars a day was not too much to pay for these pleasant surroundings. At night the tables and chairs were unhooked from the floor and piled along the sides, clearing the center of the room for the dancers, called by the inviting music of the ship's orchestra. Fizzy drinks then appeared and the place took on the appearance of a metropolitan cabaret.

Aft of the dining room was the monstrous galley in which over five hundred meals were prepared each day. I did not explore this place at first, for it was teeming with blacks. Later I made it a haven when the weather was cold. All night long the fires were kept brightly burning, and a pot of coffee was always sizzling away on the back of the stove. Here I made the acquaintance of people I would have never seen otherwise, for they were coal passers and firemen, men who are not allowed the freedom of the upper decks. Every night these fellows came up from below to get a swig of hot coffee as the coal dust ran from their faces in streams. It was only occasionally that they could be persuaded to talk, for I was considered an officer and the men from the hold were timid about speaking to anyone so near the Old Man.

On the next deck—the boat deck—was little except the life rafts and boats, bunks for the colored pantry men, and a few choice parlors up forward. Aft were skylights over the galley, the engine room and the buffet, as well as many red ventilator funnels. The upper deck was called the "flicker" but no one knew just why.

Above the forward boat deck was still another deck, called the sun deck, where friends of the Captain and officers of the boat might sun themselves in nice weather. This deck communicated with the bridge and the pilot house, and it was usually by this route that I took messages and weather reports to the skipper. In the portion to which "our deliberate brethern" were relegated was a room devoted to social activities. Here were the fights, the banjo entertainments, and the crap games. A smooth table had been placed in the center of the room over which hung a lamp, casting a dim light over the players faces as they crowded about the dice, most of the light being directed to the table top where the lucky "bones" fell. At any time of the day or night when the men were not at work in the galley, the "come seben, come 'leben" could be heard as well as the arguments and blows that sometimes resulted from a throw of the lucky cubes.

At the extreme after part of the boat deck—back of the stack—was open space where the men often stretched out on the deck and slept in the sun. Many times I have stolen up the stairs quietly and found a half dozen blacks peacefully snoozing away, some with their backs against the hot ventilators, some on top the skylight where all the odors from the galley and engine room escaped, and some flat on the deck, half covered with cinders from the stack. They seemed to sleep with one eye open; one could never make any noise up there but what the whole bunch would jump to their feet in mortal fear that they had overslept and that the boss of them all, Tom Williams, had come after them.

Tom had been in the employ of the company at least as long as the Juniata had been in service, probably longer, and had come to that state of mind where he thought he owned the ship. His manner of storming and swearing at the blacks was enough to strike fear into anyone's heart, but his never ending tirade soon palled on me.

Friction between the upper men and those who lived and worked below decks was constant. I fully expected to see a full fledged battle on the flicker before the season was over, for the men of both parties were aching for a chance to get at the others. For this reason Tom kept his men up on top and away from the lower

(*Continued on page* 28)

Across the Ocean on the NC-4

The Personal Narrative of the Wireless Operator on the Naval Seaplane Which First Spanned the Atlantic in an Historical Air Flight

By Ensign Herbert C. Rodd

PART II

(Continued from August WIRELESS AGE)

SEVERAL minutes elapsed before I had any true realization that we were actually on our way overseas. Then the steady thrumming of the motors and a sight of the gradually fading shore line served to awaken in me a quiet sort of exultation in the fact that with good luck this enterprise might go down to posterity as an event in history.

More practical things, however, almost immediately engaged my attention. In the first transmission of wireless signals, using the skidfin antenna, I noted that the lead-out to this aerial leaked slightly, undoubtedly due to the fact that considerable water had been shipped in the take-off. These first communications were with the NC-1, and when we had been in the air for about three-quarters of an hour I let out the trailing wire antenna, from which all radio messages were thereafter sent and received until we neared the Azores on the following day.

The flag plane, the NC-3, soon after inquired for our position, asking if we were just astern of her; I sent a reply requesting that she turn on her running lights.

About a half hour later, while I was communicating with Cape Race station and with the other two planes, we passed over the second destroyer, and then twenty minutes later, I heard the wireless signals from the NC-3 requesting destroyer No. 3 to cease firing star shells, as they had sighted her. Compass signals were then given and these were heard all the way to destroyer No. 10, more than 350 miles distant.

There were all sorts of interesting wireless communications registering in my head phones along about this time, one of which I recall came from the "Maumee" in the following fragmentary form:

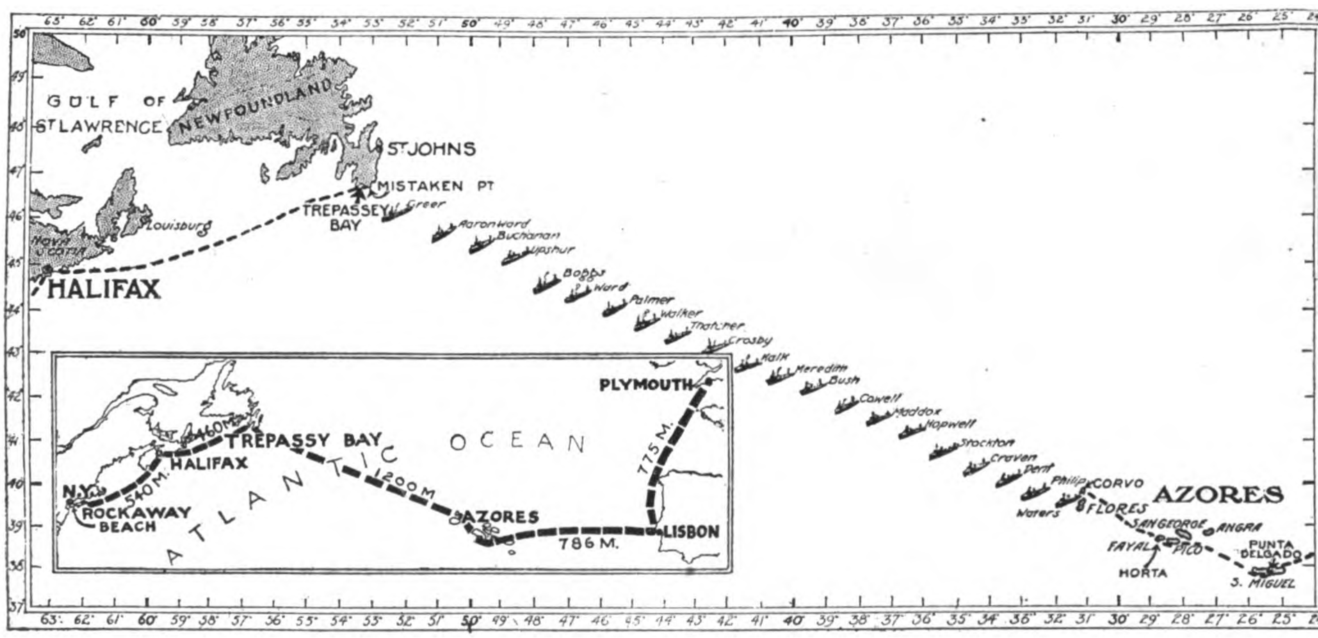
"Maumee will not be able to move for three days comma that heavy. . . ."

Afterward I heard that she had broken down while plying back and forth through heavy seas to refuel the destroyers which were waiting for us. At the time the message was received she was in the vicinity of the Azores.

Within a half hour all three planes had passed station No. 4 and Cape Race reported by wireless, "signals good," which message was clearly received. Boston—then a thousand miles distant—came in, and I clearly heard her call the Acushnet.

My next communication to the destroyers informed them that we were about to inspect the motors on the NC-4, and proposed to use the Aldis lamp for this purpose. This lamp was intended for signaling, but as a matter of fact, it was an ideal light for examining the motor, although the idea had not struck us until this time. Incidentally, I might mention here, that perhaps the most inspiring sight through the entire trip was that of the four Liberty motors, each spitting six tongues of blue flames from either side. This roaring, flashing fire symbolized a wonderful mechanical achievement, for the flames bore direct testimony to the fact that the entire forty-eight cylinders were hitting perfectly.

In contrast to the flashing of the power explosions from the motors and the vicious blue shafts that belched from their sides, was the placid disc of the moon rising slowly from the surface of the sea. Cold ladders of light led



This map shows the location of the destroyers in the lane flung across the sea for the safety of the naval aircraft; the Author's wireless communications with these vessels and the shore stations is a feature of the article

out across the black waters below us, seeming to be harbingers of a guiding hand of Fate which would lead us safely to our island objective.

Any further philosophical thoughts which I might have entertained on the subject were interrupted when I happened on the tune of 1,200 meters and heard the station at Brest being called by one who signed himself NEC. I then copied the following message:

"S/S GEORGE WASHINGTON ne-1 Ck. 126. Confran. Position eight PM GMT May sixteenth. Lat. 47-05; Long. 23-00. Expect arrive Brest seven PM. GMT Sunday May eighteenth period. Please furnish five hundred tons fresh water comma eight hundred tons coal and stevedores upon arrival period carrying capacity three hundred fifty first class passengers six thousand three hundred thirty-five troops and one hundred forty stretcher cases subject to material reduction if president and party . . . Swedish minister to United States and wife on board. Please reserve Paris train accommodations . . .. (interference from UB2 calling CQ) . . . afternoon period Major General Squier and aide on board. Please reserve Paris train accommodations for . . . . eighty sacks navy mail."

A broadcast from destroyer No. 5, directly below us, interfered with the remainder of the message.

The George Washington was then 1,175 nautical miles or 1,325 statute miles away; I am certain that this distance was never before covered by wireless to an airplane in flight from a ship at sea.

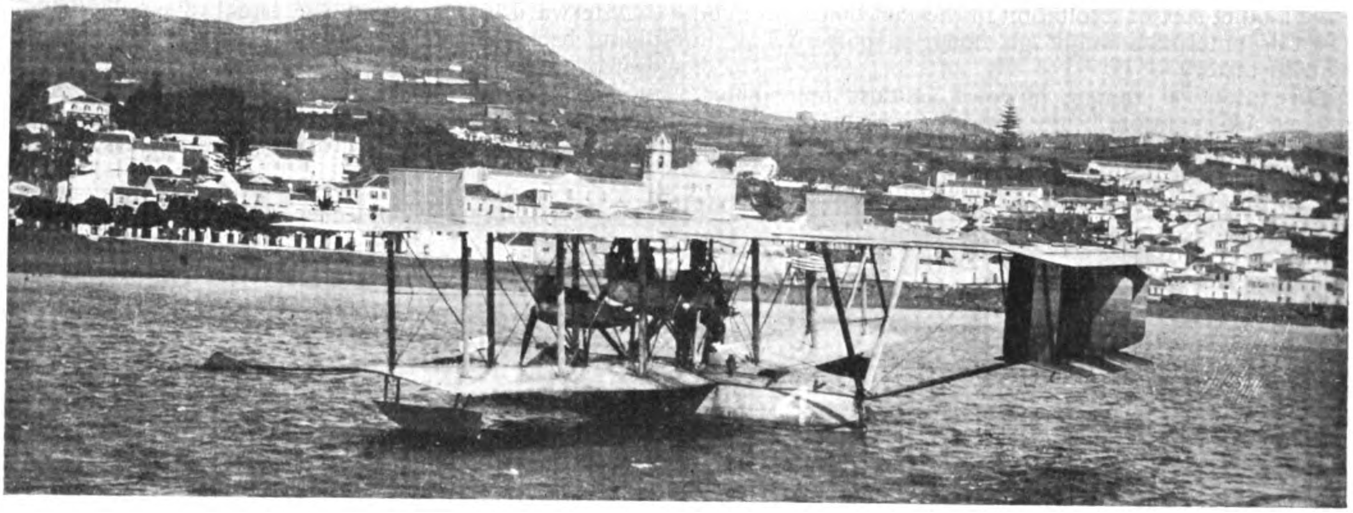
Nothing of special consequence happened for about a half hour, then the station at Cape Race asked me to send a short story of the flight thus far, the distance which we had covered, and anything of special interest. A request was also appended for a report of the NC-3. I was not authorized to transmit messages of this charatcer so I merely replied that everything was going along O. K.

A few minutes after this message had been sent, the steamship Abercorn asked if she could help us in any way; and the next episode worthy of record was when destroyer No. 7 sent me compass signals which were audible 30 miles distant. I had regularly been reporting each time when we passed a destroyer, sending these messages clear to the Cape Race station at Newfoundland. Evidently they were being received, for the operator at Cape Race answered promptly each time.

We flew over destroyer No. 8 at 3:29 (Greenwich Meridian Time), and about twenty minutes later I sent out a 22 word message to my mother in Cleveland, Ohio, by wireless to Cape Race station. We were 425 miles away from the Newfoundland station at that time, and the operator at Cape Race marveled that I was able to hear his signals, when I told him that his signals were still good. He could not understand how it was possible to hear him through all the noise made by all four Liberty motors pegging away at full speed.

Lieutenant Harry Sadenwater, the operator on the NC-1, had kept in almost constant communication with me up to this point. We exchanged friendly messages between our work with the destroyers and felt highly elated at not being "called" by a shore station. It reminded us of the early days in wireless when chit-chat exchange between operators was tolerated to a great extent.

At 4:06 I asked destroyer No. 9 for a weather report and received his reply within four minutes. This illustrates the efficiency of our communication. I cannot say whether it was due to the electrical or mechanical design of our transmitter, or whether it should be credited to the excellent work of the operators on the destroyers; in any event, it seemed just as easy to call a destroyer 300 miles away and get a quick reply as it was to communicate with one which was directly under us as we passed by in our flight.



The seaplane NC-4 at rest on the waters in the harbor of Horta, after completing the history-making flight across the Atlantic

At 5:30 the naval men at Cape Race inquired as to the time when we had passed destroyer No. 10. I informed them that I had not picked up that vessel's broadcast, so did not know: the Cape Race operator responded with a lengthy message, asking that he be kept advised as to our position. He added the final comment: "Signals great."

A half-hour later I heard at one time six destroyers sending out their compass signals, these vessels were respectively numbers 12, 13, 14, 15, 16 and 17. No. 16, the Hopewell, more than 200 miles distant came in exceptionally loud.

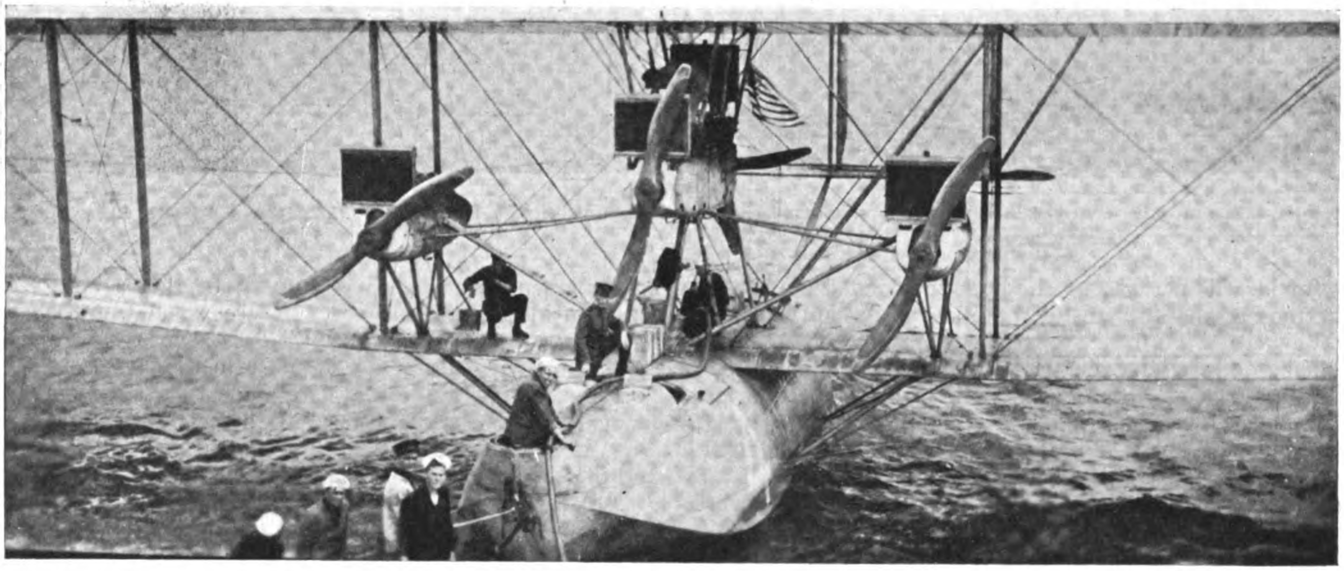
Soon afterward we passed over destroyer No. 13, which information I imparted to Cape Race. Immediately afterward I heard, clear as a bell, a 14-word message sent to the Aroostook, stating that the signals from the plane were "great."

The NC-1 then inquired whether I had heard any wireless communications of the NC-3. I listened and found that the flag-plane was communicating with destroyer No. 13, and at the conclusion of these communications I heard her ask destroyer No. 16 for a weather report.

It was about 7 o'clock when I heard the station at Bar Harbor very faintly. The messages were being communicated to two of the naval vessels, probably off the coast of Maine, Bar Harbor being almost 1,100 miles away.

A half-hour later I sent the position of the NC-4 to Cape Race, but I did not hear this station answer. This was not surprising for the last communication I had sent had spanned a distance of 650 nautical miles.

I became a bit sleepy at this time and sought the open hatchway for a few breaths of fresh air. Chief Machinist Mate "Smoke" Rhodes had slept peacefully all night covered with life preservers, the only visible part of his anatomy being two feet set at a spread eagle angle. As the cobwebs were cleared from my brain by the rush of air, I began to speculate on the reasons why there was no noticeable change in temperature, for I had fully expected it to become warm as we approahced the Azores. Then I recalled how at Rockaway I had counted on writing some letters during the long flight. I had often done this before, and in the rush of things preceding our departure I had made a mental reservation that I would catch up with several weeks correspondence; but nothing had been done on the flight; I never had a spare minute, it seemed.



The epochal flight had just ended when this photograph was taken, but to the Author this seemed relatively unimportant; he was far more concerned with securing the soothing solace of a cigarette

When I returned to the instruments I picked up Lieutenant Sadenwater of the NC-3 and remarked that the thought of sleep had never occurred to me. He replied that perhaps, too, I had not thought of food, adding that he had a sandwich in his hand at the moment. He was right; I had given no thought to the supplies we had taken aboard at Trepassey. "Smoke" was awake by this time and I scribbled off a note asking him to go back and get a sandwich. When it came, I seemed to have no taste for anything but the buttered bread. I got away with this, but passed up the coffee, for the Thermos bottle in which it was contained, was faulty and the contents were cold.

We crossed the steamer lane soon afterward and there was considerable interference on the 600 meter wave length. I heard the NC-3 calling destroyer No. 17 and by the strength of his signals I figured that the craft was a good distance ahead; the NC-1 then came in loud, and I noted that this vessel was just one station behind.

The hour between 8 and 9 was a busy one. The steamship Imperoyal wished us good luck and stated that she was bound from New York to Spain with gasoline. A few minutes later I heard two vessels calling Cape Race; one sent a message and the other reported to some station that he had met two planes and had a good time communicating with them. I found it was possible to hear two destroyers at once with the amplifier entirely disconnected from the receiver, antenna and counterpoise. A remarkable record was made, too, in this hour, when the NC-1 asked the destroyer No. 16 for a weather report and received a reply in one minute.

Destroyer No. 17 notified me at 9.31 that the NC-3 had just called with a rush message but that the operator could barely hear it. This was the last heard of the NC-3. Fifteen minutes later we struck a heavy fog and from then on I adjusted to the 1,500 meter wave length so as to get all the compass bearings possible.

The hour from 10 to 11 brought some anxiety. At 10:30 I established communication with destroyer 19 and asked if he heard our motors, explaining that we were flying between the fog and the clouds. The reply came back that the destroyer had not sighted us, but that the operator on board thought we were off her port bow. I was just about to ask for compass signals when the navigator came aft and requested me to inquire about the fog conditions close to the water in the vicinity of destroyers 19 and 20. I received an immediate reply from 19, stating that the fog was very thick near the water; destroyer 20 then wirelessed the information to me that it was misty in her vicinity. The operator on this vessel asked whether we were flying high or low and I told him: "high, but we want to come down if it is clear at the surface."

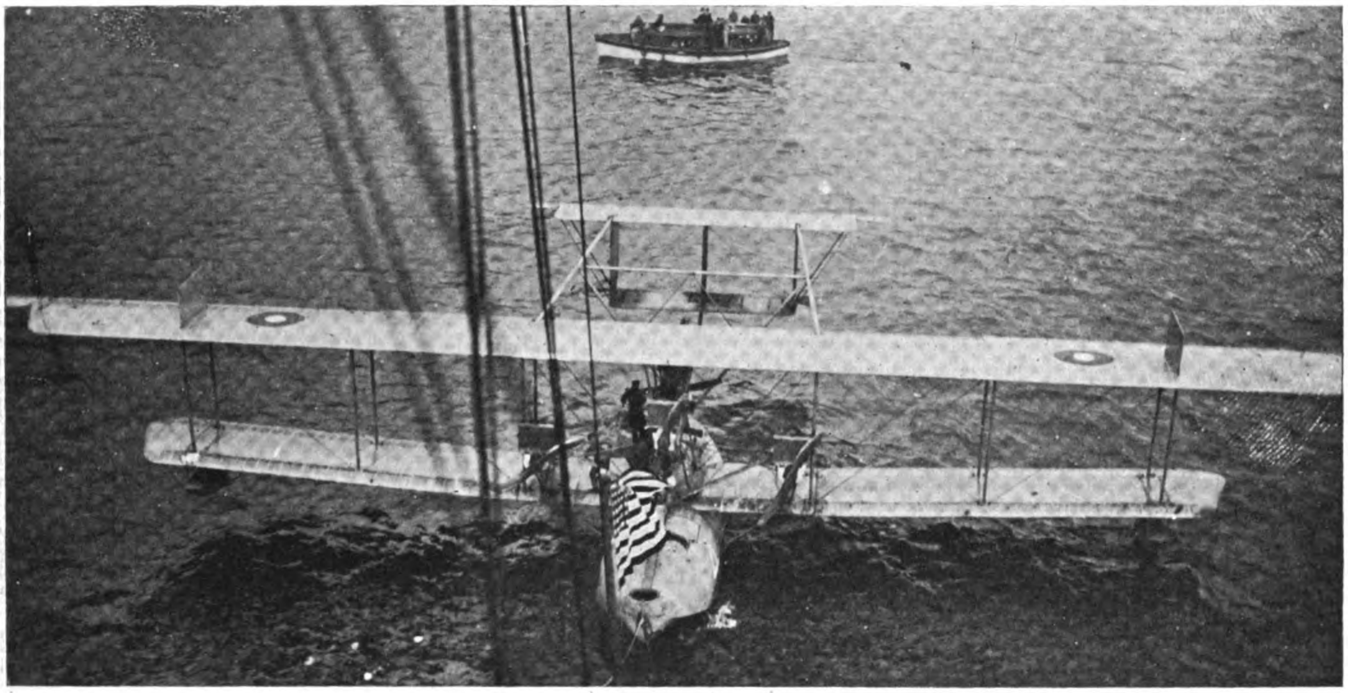
At 11:13 destroyer No. 21 replied to my inquiry that the visibility at the surface was 10 miles and that the wind was blowing at the rate of 20 miles an hour.

Then, at 11:30, we sighted Flores—the most welcome sight that had ever greeted our anxious eyes.

We came down near the surface so I reeled in the trailing wire aerial and in subsequent communications used the skid-fin antenna. We were concerned about the NC-1 and the NC-3. I inquired of destroyer No. 23 whether the other planes had been heard. A reply stated that the NC-1 had passed two hours earlier and that a message had been intercepted stating that the NC-3 was off her course between destroyers 17 and 18. The information immediately followed that the NC-3 had just been heard, asking for bearings.

Forty minutes later we picked up land again, sighting rocks that were so close on our bow that the craft had to be raised instantly to avoid striking them. As we came down to the surface of the water, I worked with the Cruiser Columbia lying in the Bay of Horta.

Hardly had we brought the craft to a standstill when the captain's gig of this vessel came to meet us. The doctor on the Columbia evidently expected to find us all



The NC-4, just after the craft had been brought to a standstill on the conclusion of the cross-ocean flight to the Azores, a dramatic moment in the annals of aviation

in, for he was perched on the bow and loaded down with Thermos bottles full of beef bouillon and stimulants.

We were by no means exhausted, but the hot beverages looked good and no member of the crew refused them. Welcome as this attention was, however, the important thing to me was the opportunity at last to get a smoke. All night I had been tantalized by the fragrance of cigarette smoke wafted through the passageways of the plane. Commander Read had permitted smoking in the forward compartments of the plane, but aft of the gas tanks it was considered dangerous and there was nothing doing for me.

As I looked back at it now it seemed relatively unimportant that our landing at Horta meant the accomplishment of the first successful air flight across the ocean. I was far more concerned with the relaxation of restrictions and the soothing solace of a cigarette.

(To be Continued.)

A Summer on the Great Lakes

(Continued from page 24)

decks but there was little to prevent the firemen from coming up on top after the blacks. If ever a time comes when the two gangs of men decide to have it out—and such a time must surely come—there won't be any Juniata left. Of the total crew of a hundred and thirty, at least sixty were black, so one could expect a pretty good battle—and an even one too.

Below us was the berth deck, so called because most of the staterooms were here. Here, too, was the barbershop, more bunks for the engineers, barber, bellhops and some of the colored fellows who could not be accommodated on top; also the "fantail." This was the extreme after end of the ship where the huge coils of rope—the breast and stern lines—a steam capstan for making fast the line, and a shower bath for the crew were conveniently located. The shower consisted of a hose placed in the center of the space and hooked to the ceiling or deck above, so that it could be moved about by the recipient of the water. As the fantail was decidedly open to the public, shower baths were prohibited during the day time and when near port. Only when the ship was on the "high seas" could the affair be used; even then I doubt if it was ever used, for the officers had a shower of their own, less public by far; and the crew—well I am not sure that they thought an occasional shower necessary.

One man always went swimming in the third engineers trousers when we docked at Mackinac, but the rest of the crew must have been cleansed by liquid fire and suggestion rather than by the use of water. So the fantail was used not for a bathhouse, but for the customary shipboard poker and crap games. Here the members of the crew made and lost their money, several hundred dollars often changing hands in a single day. The rail and the capstans were filled with shouting followers of the game who tossed their quarters and halves into the ring with the utmost abandon. Only when the steamer docked did the dice game stop, and then only because the players were afraid of police, or because they needed their money for refreshments.

Still another deck was below the berth deck, this one being used for most of the freight which could not be stored in the hold. Here was the passenger gangway with the offices of the Purser and Steward on opposite sides of the stairs leading to the upper decks and the social hall. The engine room was also on this deck, although the engines proper were still further down, and there usually was a pile of coal which was carried on deck and not placed in the bunkers. This was used in cases of emergency when the coal below was gone or on fire and could not be used. On this deck was stored the copper and zinc ingots which usually comprised part of our freight. The flour and dry goods cases and such stuff were swung into the hold by steam winches which kept up their terrible squeak for a day and a night while we were in Buffalo and Duluth.

EXPERIMENTERS' WORLD

Views of readers on subjects and specific problems they would like to have discussed in this department will be appreciated by the Editor

A Simple Buzzer Transmitter for Amateur Use

THE buzzer type transmitting set will no doubt find wide application in the experimental field due to the ease of construction and low cost. The instructions here given, were purposely made very general in order to encourage the experimenter to follow his own initiative in varying certain dimensions. Since the cost of these experiments will be very slight and will require little else than time and patience, the amateur will no doubt welcome these general instructions rather than the more explicit instructions given in the usual constructional article.

Buzzer transmitters have been made in a variety of sizes for various uses, powers and voltages. In a subsequent article photographs and descriptions of the standard transmitters furnished to the Navy and Signal Corps will be given. The purpose of this article is to describe a 75 watt outfit suitable for operation on 110 volts D.C. Figure 1 shows the elementary wiring diagram. The iron core choke which operates the buzzer contacts, for use on 110 volts should have a core of No. 22 soft Norway iron core wire about 1" in diameter and about 4½" long. The winding space is about 4" long and ¾" deep making the diameter of coil over the winding about 2½". The space is wound full of No. 22 B&S D.C.C. magnet wire.

The vibrating spring of the buzzer, figure 4, is made of 1/32" spring steel or cold rolled steel, preferably the former, 1" wide and 5½" long. On the rear of the spring is fastened an armature of soft iron 1" in diameter and ¼" thick. On the front of the spring is mounted a piece of copper of the same size as the armature to which is soldered a piece of 1/16" sterling silver which acts as the vibrating contact. The stationary contact is formed as shown in figure 2, and is also fitted with a piece of sterling silver 1/16" thick and 1" in diameter. Figure 3 shows a simple way of supporting the stationary contact, figure 2. It is made of 1/16" sheet brass 1" wide and is bent as shown.

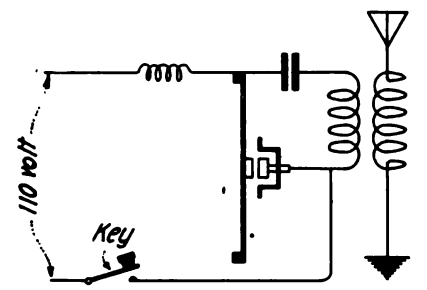


Figure 1

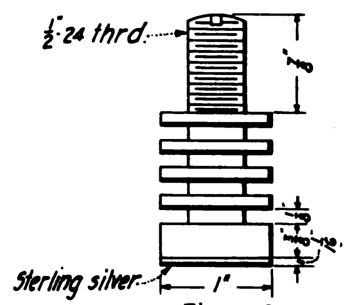


Figure 2

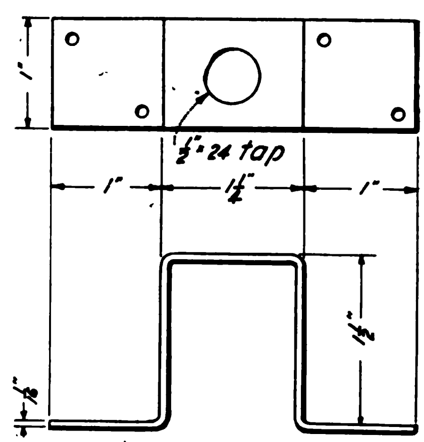


Figure 3

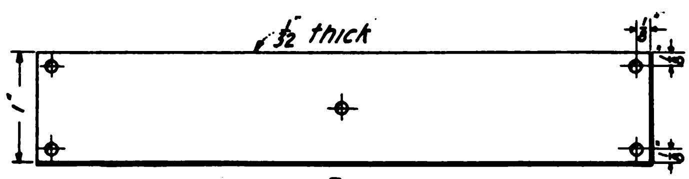


Figure 4

Constructional details and dimensions of the buzzer transmitting set

The condenser is easily constructed of mica or glass plates. The dielectric must only withstand a break-down test of about 500 volts. For 200 meters, the capacity should be about 0.013 mfd. Any standard text book will show the experimenter how to calculate the dimensions of this condenser. It can be purchased quite cheaply because the voltage is very low.

On account of the low voltage generated in this set, practically any kind of an oscillation transformer can be used. A suitabe transformer has about 15 turns of No. 12 B&S bare copper wire, wound on a form about 11 or 12 inches in diameter. One or two turns placed on the inside act as the primary. The primary need not be moved with respect to the secondary as the oscillations in the primary are quenched so rapidly as to give almost *impact excitation.* For all wave lengths between, say 150 meters and 300 meters, it is necessary only to add more or less turns in the secondary while the primary and coupling remain constant.

The contacts are the most expensive part of the outfit; in order to get a good job done in sweating the silver to the copper, it is advisable to have the work carried out by a jeweler. The contacts need to be large for the reason that currents in the neighborhood of 40 amperes flow in the oscillating circuit so it is necessary that the contacts be faced off absolutely parallel in order not to pit the silver, but to make use of the entire contact surface.

The theory of operation is as follows: Referring to figure 1, when the key is depressed current flows through the iron core inductance, thence through the contacts which are normally closed and back to the line; this energizes the iron core choke and it attracts the iron armature and abruptly opens the circuit at the contacts. The energy stored in the choke—equal to $\frac{1}{2}LI^2$—now flows through the closed oscillatory circuit which bridges the open gap and charges the condenser. The energy stored in the condenser—$\frac{1}{2}CE^2 = \frac{1}{2}LI^2$—discharges across the now closing gap and produces damped oscillations which are quickly damped out in the primary circuit. The secondary circuit then oscillates

at its own natural period. The action of course, is repeated indefinitely as long as the key is depressed.

As mentioned before, the primary oscillations are quenched out so rapidly as to give substantial impact excitation. Let us now consider the reason for this rapid quenching. There are many factors which contribute to quenching. They are enumerated as follows:

1. The cooling effects of the massive metal plates.
2. The magnetic blow-out due to the magnet coil mounted behind the contacts.

The mechanical quenching due to the contacts actually closing or opening the circuit.

4. The re-transference of energy from the secondary back to the primary due to the close coupling.

The set is adjusted as follows: Depress the key and screw up on the stationary contact until a smooth note is obtained and an ammeter in the primary source of power reads about 0.75 amperes. Next adjust the number of turns in the secondary circuit until the wave length is the correct value as indicated on a wave meter. On a small antenna a radiation of about 1 ampere may be expected and a distance of about 20 miles can easily be covered. This outfit will produce a very smooth but low note and is practically noiseless in operation. If a commutator form of "chopper" is inserted in the ground circuit any note desired can be produced at the will of the operator by simply varying the speed of the motor driving the chopper.

Some items to experiment with are the variation of air gap between the choke coil and vibrator; making the choke coil core movable and noting its effect on the note without the chopper; and last but not least the re-design of the coil and the adaptation of the set to alternating currents.

M. W. Sterns—*New York.*

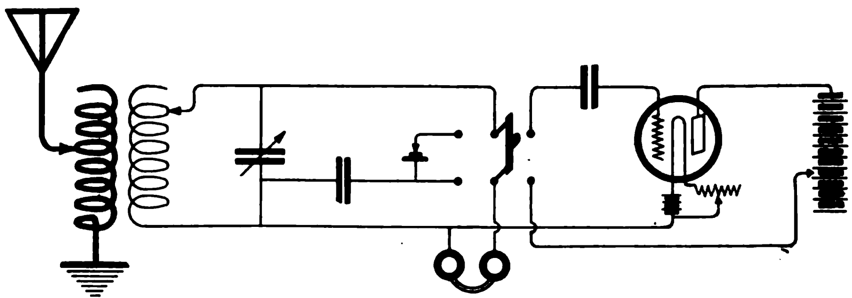
List of Long Wave Stations

Call	Location	Type	Wave-length
BUC	Taranto	Arc	3,500
			4,166
BWP	Punta Delgada, Azores	Arc	2,000
BWW	Gibraltar	Arc	2,750
		Spark	4,600
BUCQ	Jassy, Roumania	Spark	6,000
BXY	Hong Kong, China	Arc	5,000
BYC	Horsea, England	Arc	4,500
BZI	Jacobs, Durkin, S. Africa	Arc	2,700
BZK	Bathurst, Sierra Leone, W. Africa	Arc	3,600
		Spark	2,000
BZL	Demarara, Br. Guiana	Arc	4,200
		Spark	1,279
BZM	Mt. Pearl, N. F.	Arc	4,200
		Spark	1,525
BZO	Ascension Islands	Spark	4,600
BZQ	Christiana, Jamaica	Arc	4,200
		Spark	1,280
BZR	Bermuda	Arc	4,200
		Spark	1,525
BZV	Port Nolloth, Hong Kong	Arc	2,000
		Spark	3,263
BYZ	Renella, Malta, Med. Sea	Arc	4,600
		Spark	4,600
FFH	Bezierte, Tunis, N. Africa	Arc	6,000
FKQ	Martinique	Spark	1,000
FL	Eiffel Tower	Arc	10,000
GB	Glace Bay, N. F.	Spark	7,500
ICI	Coltano, Italy	Spark	6,500
IDO	Rome, Italy	Arc	11,000
LCM	Stavanger, Norway	Timed	12,000
		Spark	9,500
LP	Berlin, Germany	Spark	5,500
MFT	Clifden, Ireland	Spark	6,000
MUU	Carnarvon, Wales	Arc	14,000
MPD	Poldhu, Ireland	Spark	2,800
NAA	Arlington, Va.	Arc	6,000
		Spark	2,500
NAD	Boston, Mass.	Arc	5,000
NAM	Norfolk, Va.	Arc	5,250
NAO	Charleston, S. C.	Arc	4,750
NAR	Key West, Fla.	Arc	6,500

Call	Location	Type	Wave-length
NAU	San Juan, P. R.	Arc	5,000
NAW	Guantanamo Bay, Cuba	Arc	4,500
NAY	Pt. Isabell, Texas	Arc	8,500
NBA	Darien, C. Z.	Arc	7,000
NDD	Sayville, L. I., N. Y.	Generator	9,800
			11,600
NFF	New Brunswick, N. J.	Generator	13,600
NPG	San Francisco, Cal.	Arc	8,600
			4,800
NPL	San Diego, Cal.	Arc	13,300
			9,800
NPM	Pearl Harbor, Hawaii	Arc	11,000
NPN	Guam, M. I.	Arc	5,000
NPO	Cavite, P. I.	Arc	12,000
NPU	Tutuila, Samoa	Arc	6,000
			3,000
NSS	Annapolis, Md.	Arc	16,900
NWW	Tuckerton, N. J.	Arc	9,200
OUI	Eilvese, Germany	Generator	15,000
PMX	Java, Dutch, E. I.	Arc	6,100
POZ	Nauen, Germany	Generator	12,600
SQC	Cairo, Egypt	Arc	5,800
SUC	Suda	Arc	5,860
			3,870
UA	Nantes, France	Arc	11,000
			9,000
VCU	Barrington	Spark	1,525
			3,500
VJZ	Rabaul (Pacific)	Spark	2,900
VKT	Nauru (Pacific)	Spark	2,200
VMG	Apia, Samoa	Spark	2,000
VPW	Singapore, Malay Peninsula	Arc	3,400
WSO	Marion, Mass.	Timed	2,000
		Spark	2,000
XDA	Mexico City, Mexico	Spark	4,000
YN	Lyons, France	Arc	15,500
	Aden	Arc	4,441
	Amethyst	Arc	4,200
	Corfu	Arc	6,000
	Milo	Arc	4,160
	Toulon	Arc	6,000

Change-Over Switch for Use of Audion or Crystal Detector

THE accompanying circuit shows a very simple and efficient method of using either a crystal or a valve with the receiving tuner. One movement of a switch is all that is necessary to change the tuner and telephones from one detector to the other. The switch may be either the regulation double pole, double throw type, or of the pole changing pattern, which has two levers connected by an insulating strap carrying the handle. Of the two contacts at the rear of this switch, one is connected to each lever, and each lever slides over two of the four front contacts. This latter type of switch may be easily constructed of six. ordinary switch-points and the scrap to be found in any radio man's laboratory. It may be placed directly on the front of the receiving cabinet in a space a little over an inch square.



Circuit using either a crystal or valve with the receiving tuner

This circuit was designed and thoroughly tested out by Mr. George A. Wolf, one of the radio operators at New York Police Headquarters, and so far as known is the simplest and most efficient method of accomplishing the change-over from the valve to the crystal detector. It will be noted from the diagram that placing the switch on the left contacts gives the standard crystal detector circuit; when placed on the right contacts, the standard audion circuit results, and on either position, very few "hanging-on" pieces of apparatus appear.

In many instances an operator desires to save valve material for delicate work, and to use a crystal detector for ordinary receiving. A panel set equipped with both types of detectors and this circuit makes an ideal receiving outfit, and may be as readily constructed as a single detector type. The use of the pole-changing type of switch is advised, because of its neat appearance and the small space required.

For receiving undamped waves a wire may be led from the aerial lead, direct to the plate, as in the circuit developed by Mr. Chambers a few years ago. When this is connected, undamped waves up to the wave length of the tuner may be received. this lead may be inside the case of the receiving set, and arranged to be connected, at will, to the plate circuit by a single small switch which would be as near to the plate lead as possible.

Amplifying valves may be connected to this valve in the usual manner; and other detectors, or a potentiometer may be used on the crystal side. While it is possible that such additions may cause a slight change in the dead-end effect, it is hardly probable that this would be detrimental to the efficient operation of the circuit.

CHAS. E. PEARCE—*New York.*

Variable Tuning Inductance

THE variometer, besides being cheaply and easily constructed is a very useful instrument for the amateur wireless station, as it allows a gradual variation of the wave length in receiving circuits. This is important since close tuning is a necessity for efficient work in long distance reception. The energy losses due to the resistance of the winding of a large variometer are appreciable when used at small values of inductance, but it is a good instrument to use in series with a loading coil, for tuning between the taps of the coil.

The accompanying drawing shows a method of incorporating the variometer and the loading coil in one instrument making a compact and easily operated tuning inductance, and giving a gradual variation of inductance from practically zero up to any value desired. The coil in figure 1 consists of No. 28 S.S.C. wire wound on a 5" tube. It is arranged in 3" sections as shown, a tap being taken at each section and connected to a multi-point switch. Since this wire winds 60 turns per inch, there will be 180 turns per section. The two bottom sections are ¾" long, each consisting of 45 turns. The rotor coil also has two ¾" sections of 45 turns each. Leads are brought from this coil with extra flexible cord, and connected in series with the outside winding. One of these leads connects to one of the binding posts. The other binding post is connected to the shaft of the multi-point switch. The tube on which the rotor coil is wound is 4¼" in diameter by 2" long which allows enough clearance if the thickness of the outside tube is not over ⅛". The drawing shows clearly the method of mounting the rotor coil. Since every experimenter will use the material at hand no minor details are covered.

The inductance is varied by means of the multi-point switch and by rotating the inside coil. When this coil is tuned so its magnetic field opposes the field of the outside coil, the inductance is minimum; when tuned so its magnetic field assists the field of the outside coil, the inductance is maximum.

The length of the outside tube and the number of 3" sections wound on it depends upon the wave length of the signals it is desired to receive.

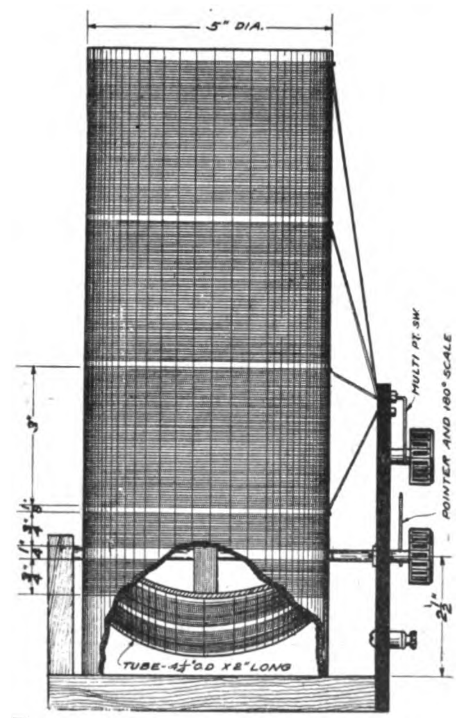


Figure 1—The variometer and loading coil combined in one instrument to form an easily operated tuning inductance

If this coil is used with the regenerative vacuum valve circuits for the reception of undamped waves, the control handles should be at least 12" from the coil, otherwise the presence of the operator's hand near the coil affects the signals. When the inductance is adjusted to the signals, removal of the hand from the control handles will eliminate the signals if the control handles are less than 12" from the coil. Any movement near the instrument will change the tone of the signals. This is due of course, to the capacity of the operator's hand, which changes the natural frequency of the circuit.

C. J. FITCH—*Massachusetts.*

First Prize—Long Wave Receiver

By C. R. Leutz

FIGURE 1 shows the layout of a receiver which has a range from about 2,000 to 20,000 meters when used with the average amateur antenna. I claim for this receiver that it is particularly selective and at the same time simple in construction. Selectivity on long wave lengths, now that there are so many high power stations working on this side of the Atlantic, is particularly desirable if one wishes to receive the trans-Atlantic and trans-Pacific stations at all times.

Figure 2 is a theoretical wiring diagram and together with figure 1, the conclusion is reached that amateurs generally have not only failed to find a really good method for affecting reception on the long waves, but that a great many of them apparently do not thoroughly understand the requirements for this sort of work. There is an impression among amateurs, and this is quite general, that better signals are obtained when direct coupling between antenna and closed circuits is used. This opinion is persisted in no doubt due to the fact that louder signals may be obtained from the high power stations which are near by. Direct coupling gives directly to the antenna circuit and capacitively couple the plate circuit in this way to the grid circuit. Still many others use odd and various combinations of the above three methods with what pretends perhaps to be a proper and logical method. It is apparent that under circumstances such as these, the control of the coupling between wing and grid circuits is usually uncertain and in some cases no real control at all is available. Perhaps it might be pointed out that in order to obtain oscillations from a three element vacuum tube, it is necessary to couple the plate circuit with

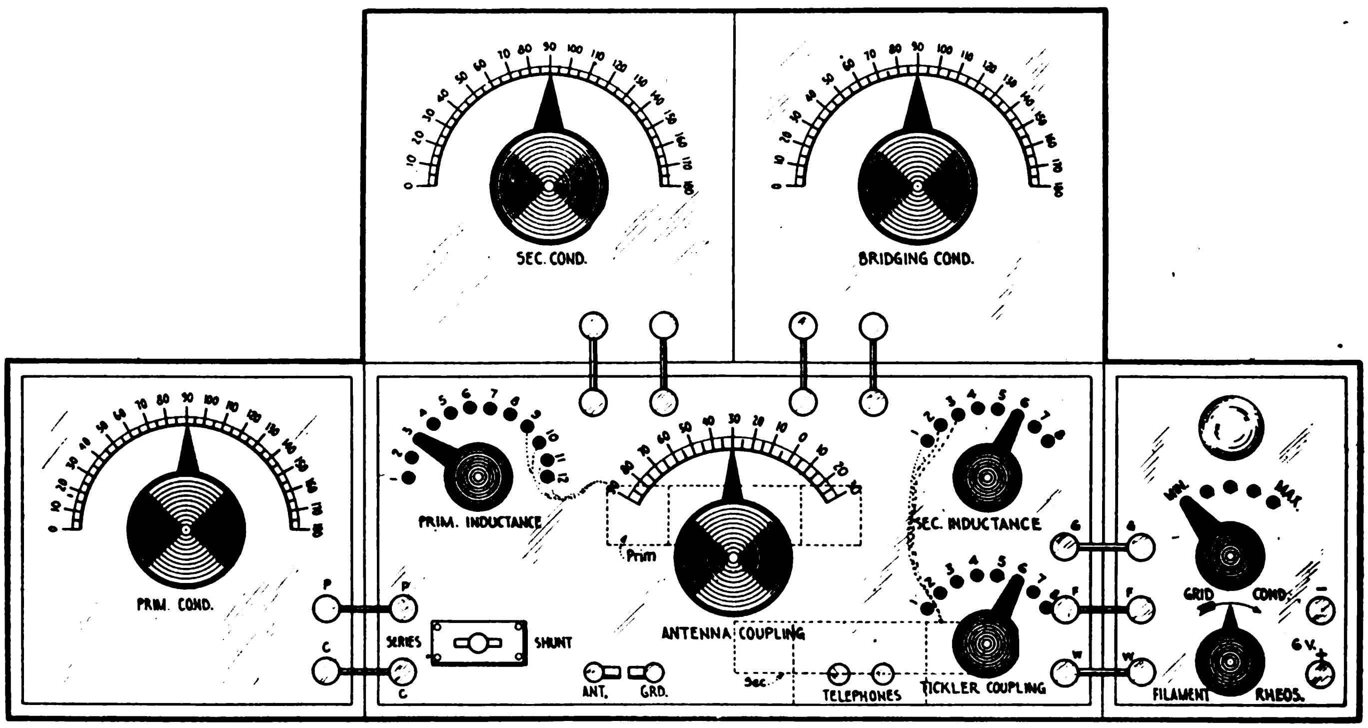


Figure 1—Main panel of the long wave receiving set showing position of instruments

will give the reader a very good idea of what is required in the way of apparatus. This apparatus in addition to the coupler cabinet, consists of a primary condenser, a variable condenser, a bridging condenser, and the audion panel. These three variable condensers should have approximately a maximum capacity of .001 mf. Larger condensers, of course, may be used as well as smaller, but the wavelength range will be increased or decreased accordingly.

It has been considered unnecessary to show the construction of the switches, condensers, audion panel, etc., inasmuch as these subjects have been covered in previous articles in The Wireless Age and are subjects more or less familiar to all amateurs.

From articles which appear in print from time to time and from questions which various amateurs have asked, rise to losses which are serious when incoming signals are weak.

Although various articles which have been printed from time to time in The Wireless Age, and all recent text books giving data on vacuum tubes and vacuum tube circuits, have very clearly pointed out the methods of securing regenerative and oscillatory action in a vacuum tube receiver, there still seems to be considerable confusion in the mind of the amateur as to how this may be accomplished. Some seem to be satisfied with the placement of the telephone receivers in common to grid and plate circuits, the two circuits being coupled by virtue of the capacity in the telephone cord and in the magnet windings. Others resort to capacitive coupling between the plate of the detector tube and the antenna circuit and thence to the secondary or grid circuit. Still others connect the plate of the detector the grid circuit. This may be done inductively or capacitively, or the plate circuit may be tuned to the same frequency as the grid circuit, in which case that small amount of coupling provided by the connections to the filament and the filament itself which are common to both plate and grid circuits give sufficient coupling to set up oscillations when the two circuits are in resonance. This, of course, is inductive or conductive coupling. It is quite apparent that any combination of inductive and capacitive coupling with wing tuning in addition, will provide oscillations, but for all practical purposes, the simplest method which will give a generation of oscillations and at the same time afford perfect control over a wide range of wavelengths, is the most desirable method.

Any claim to novelty which the receiver here shown may possess lies

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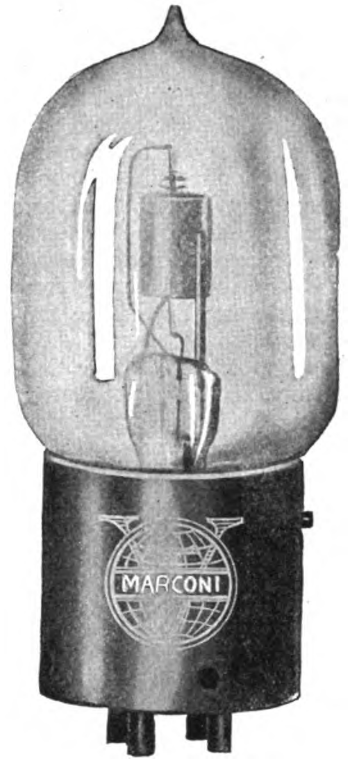

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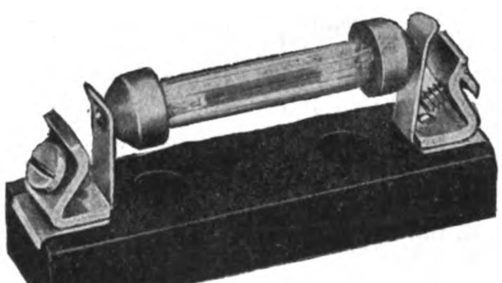

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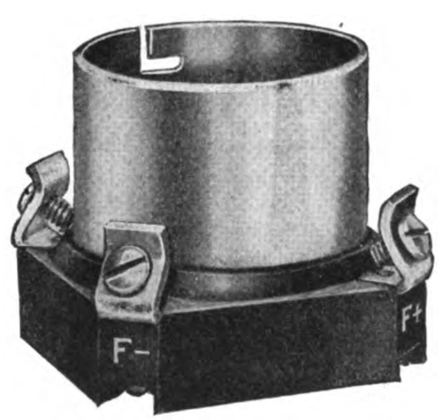

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principally in the type of coil used, the method of securing inductive coupling between wing and grid circuits, and in the mechanical arrangement of the antenna circuit and closed circuit inductance. The wing-grid coupling in this case is obtained by making a portion of the closed circuit inductance common to both wing and grid circuit. The amount of this common inductance is determined by the position of the "tickler" switch. Final adjustment for effective coupling between the two circuits is had by use of the bridging condenser which is shunted across the telephone receivers, but the primary of the amplifier determines if an amplifier is used. The control of oscillations thus provided is all that can be desired. This method has been chosen due to the fact that only two coils are required; that control of oscillations is equal to the control provided by any other method; and because the range over which oscillations may be secured is perhaps very much greater than any other method conveniently available. The use of a third coil in the plate circuit, the third coil being coupled to the secondary inductance, also provides a very good means of securing oscillations, and has been used in the later models of the Navy receiver. but unless considerable care is exercised, the electrical constants in this third coil are quite likely to be such that the third coil or tickler coil has a fundamental wave-length within the range of wave-length it is desired to receive. in which case the energy losses in the third coil at or near this wave-length will be so great that no oscillations are possible.

The coils are wound as follows:

Secondary coil: Winding form, 2½", outside diameter, 1¼" wide. Wind on 6 turns of .01" paper, shellac together, next, starting about 3/16" from edge wind on a layer of 32 turns of No. 20-38 Litzendraht, 22 S. C. C. or 22 D. S. C. This is then to be covered by one layer of 10 mil paper, the wire carried back to that side where the winding was originally started, and a second layer placed on, etc., etc., until 33 layers or a total of 1,056 turns have been wound on. Two or three layers of paper are then wound on top of the last layer of wire, shellaced, and the entire coil taped with cotton tape about ½" or ¾" wide. During the process of winding, taps should be taken out as follows: For secondary inductance switch, tap at 4 layers, 7 layers, 10 layers, 14 layers, 18 layers, 23 layers, 28 layers, and 33 layers. For tickler coupling taps should be taken out as follows: 15 turns, first layer, second layer, third layer, fourth layer, fifth layer, sixth layer, and seventh layer. All the secondary taps should be led to secondary switches in order, and all tickler taps to the tickler switches in the order that they are taken out; that is, the taps from the fourth, seventh, tenth layers, etc., in the case of the secondary, should be led to switch contacts 1, 2, 3, etc., and taps taken out at 15 turns, one layer, two layers, etc., should be led to switch contact numbers 1, 2, 3, etc.

The above method gives a coil which has been bank wound by layers.

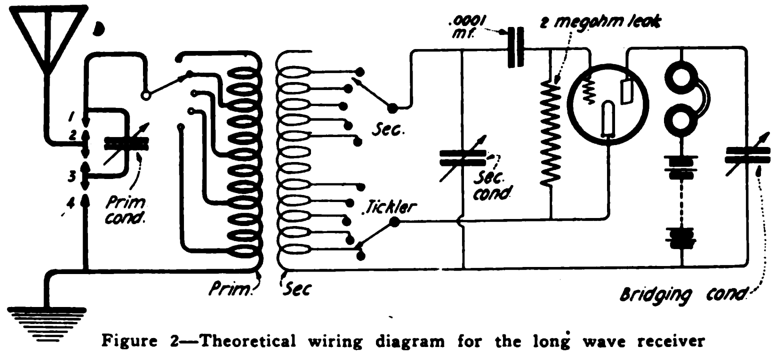


Figure 2—Theoretical wiring diagram for the long wave receiver

This method of winding decreases materially the distributed capacity of the coil and this distributed capacity is still further lessened by the introduction of a good grade of paper between layers. A coil manufactured in this way is a great deal freer from dielectric losses than a coil which is not bank wound and which does not have separation between layers, and it is the writer's opinion that the effort required for construction will be well repaid by the difference between the results obtained on a coil of this type and anything which can be purchased.

The primary coil is wound in the same manner on a form 3" outside diameter and 1¼" wide, 32 turns per layer, and 27 layers, taps being taken out at the end of the 3rd, 5th, 7th, 9th, 11th, 13th, 15th, 17th, 19th, 21st, 24th, and 27th layers, these taps leading to the respective switch contacts of the primary switch.

After the coils have been wound and taped, they should be baked in the oven for a period of one or two hours at a temperature not exceeding 200° F. at which time they should be removed and varnished immediately with a good grade of insulating varnish, or, if this is not available, with shellac made by mixing flake shellac with 95% alcohol. After varnishing, they

should again be baked for a period of two hours or so at the same temperature, until the varnish is thoroughly dry and hardened.

This treatment insures a moisture-free and moisture-proof coil. The coils are then ready for use in the coupling device which is shown in detail in figure 3 where dimensions of the individual parts are also given. At maximum coupling, or 90° on the coupling scale, the two coils will lie in planes which are at right angles but the plane of the one coil does not cut the center of the other coil. If this were the case, the coupling between the two coils would be zero, but if off center, and both of them still in a vertical position, the primary coil may be so placed as should the distance as shown in figure 1 prove incorrect with the particular coils which might be made up for this receiver any failure on the part of the device to provide zero coupling when the coils are in parallel planes, may be overcome by tilting the coils slightly one way or the other.

For best appearance, the length of the coupler case might be made to equal the width of two variable condensers and the height of the case to equal the width of one variable condenser. A small audion panel may then be made to match, but if desired, it would be possible to make a large panel to include the coupler, the three variable condensers, and the audion panel, although it is suggested

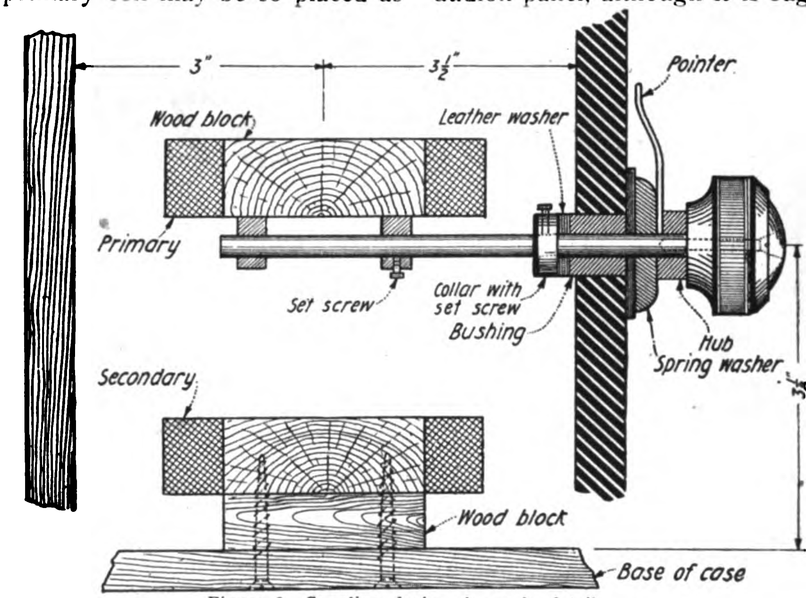


Figure 3—Coupling device shown in detail

to give the proper co-efficient of coupling for wavelengths within the range of this receiver, as is approximately the case in figure 1. At the maximum position or thereabouts on the scale (zero degrees) the coils are in parallel planes but do not have a common axis. The more nearly common their axes the greater the coupling between the coils when their planes are in parallel, but as their axes are separated the coupling decreases and reaches a minimum at that point where, if the coils were of the same size and same construction, the axes are separated a distance equal to the mean radius of the coils. The proper distance to be chosen between the axes of the primary and secondary coils when their planes are parallel (pointer at zero degrees) will have to be determined by experiment if it is desired to have zero coupling when the pointer stands at zero. The negative portion of the scale is provided in order that any electrostatic coupling between condensers or any electro-magnetic coupling arising from wiring, may be neutralized. This negative coupling will also take care of any miscalculation in the placing of the coils. That is. that from the point of view of utility, most amateurs will find it better to follow the method outlined. In the lower left hand corner of the main panel in figure 1, a telephone type of switch is shown. This is a double pole double throw switch and is used for throwing the primary condenser either in series or in shunt.

In operating this receiver, the following procedure may be observed. An arbitrary value of secondary inductance and capacity is selected and the tickler coupling increased from left to right until oscillations start. The beginning of oscillations will be indicated by a dull thud in the telephone receivers. If the tickler switch is carried still further to the right sometimes a howling or squealing will result, indicating that the coupling between wing and grid circuits is too great. Switch should then be retarded until this howling just ceases. Another indication of oscillations may be had by touching the finger to the grid terminal of the receiver. If a click is heard both when the finger touches and when the finger leaves the terminal, the circuit is oscillating. Any failure of oscillations to start may be due to an incor-

rect value of bridging condenser, antenna coupling, tickler coupling, filament current or plate potential, assuming, of course, that the receiver is properly wired.

Once oscillating, the coupling is set rather close, and the primary circuit adjusted by the use of primary inductance and primary condenser until the primary circuit is in resonance with the secondary. This resonance point will be indicated by the fact that static and signals approach and pass through a maximum, but if there is no static or no signal, a click should be heard as the primary condenser carries the circuit through the resonance point, the strength of this click depending upon the degree of coupling between the two circuits, or, if the coupling is very close, two clicks may be heard, the first indicating that the secondary circuit has ceased oscillating due to the effective resistance introduced by bringing the antenna circuit into resonance, and the second click indicating that the secondary circuit has re-commenced oscillations after the effective resistance of the primary circuit has been removed. Generally speaking, comparatively low values of coupling between the two circuits give the best signals (close coupling increases the resistance of both circuits) and, of course, greater freedom from static or interference. By moving from tap to tap of the secondary inductance and by adjusting the tickler coupling and bridging condenser so that oscillations are at all times being set up, and by, at the same time, keeping the antenna circuit somewhere near the resonance point, it is possible to cover the entire range of the receiver and thus pick up and log for future reference, the various stations which may be operating.

Once a station is heard, primary, secondary, and coupling are carefully adjusted and finally, the tickler coupling or bridging condenser is decreased until a maximum signal is heard. It may then be well to further decrease the antenna secondary coupling, to retune antenna and secondary circuits and to make a final adjustment of the bridging condenser.

The above procedure has been outlined as applying to undamped wave stations. Damped wave signals may also be heard with the circuits in an oscillatory state, but the note of the spark signal will be changed due to beats occurring between the damped oscillations of the spark signal and the undamped oscillation generated in the receiver itself. If it is desired to receive spark stations on their natural spark tone, it is only necessary to reduce the tickler coupling or bridging condenser value to that point where oscillation of the circuit just ceases, at which time the natural spark tone will be evident.

Second Prize—Long Wave Receiver

By L. M. Clausing

EASE of manipulation as well as high efficiency should be given consideration in the construction of a long wave receiver. Efficiency is quite often attained by the amateur, but ease of manipulation is usually sacrificed, often by the choice of a circuit using a multiplicity of condensers and loading coils. I recall that my first set required at least three loading coils and five variable condensers, all of which were scattered over a large table to avoid undesirable couplings. To some experimenters, the space factor may not be of importance but large loading coils and condensers provided with long handles to get away from the great sensitivity to capacity changes resulting from the proximity of the operator's body are not convenient for practical work and usually require a very critical adjustment.

Another consideration of great importance to most amateurs is the cost of construction and maintenance. When amplifiers are used, one "A" and one "B" battery should suffice for all bulbs. The potential of the grid in each bulb should be such that the greatest efficiency is secured without burning the filament at an excessive brilliancy.

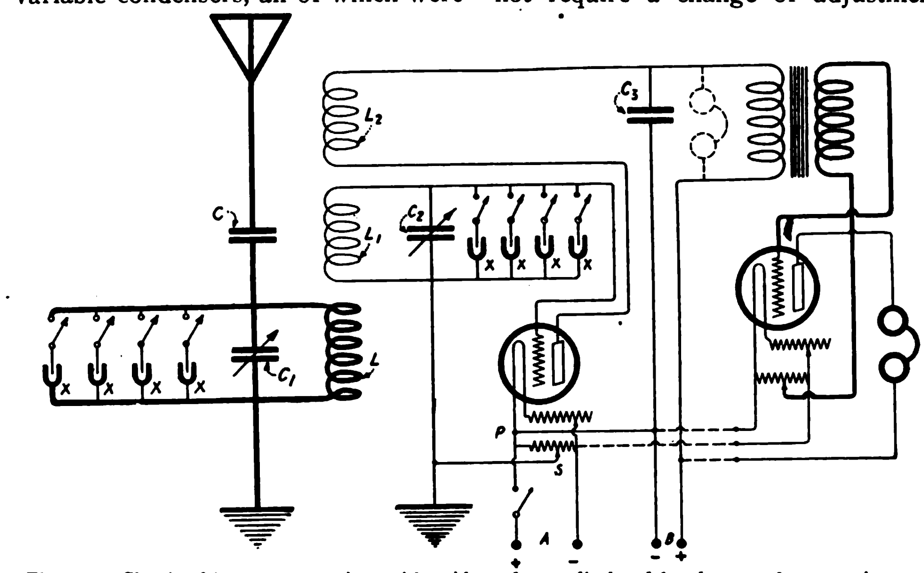


Figure 1—Circuit of long wave receiver with grid condenser displaced by the use of a potentiometer

A form of feed-back which does not require a change of adjustment for small changes in wavelength is also desirable, and when small feed-back adjustments are necessary they should not appreciably affect the secondary tuning.

In the circuit which follows, the grid condenser has been eliminated and the grid given the proper potential with respect to the filament by the use of the potentiometer P. The adjustment required for tuning to long wavelengths are accomplished by a

variation of primary capacity C_1 and secondary capacity C_2. C is a fixed condenser of .00008 mf. P is a potentiometer with a total resistance of 100 ohms. The inductances L, L_1 and L_2 are of the new "honeycomb" type. They are small in size and the distributed capacity of the windings is sufficiently low for all practical purposes. Each of these coils has an inductance of 35 millihenries.

The condensers C_1 and C_2 have rotary plates so shaped that the capacity varies more nearly directly in proportion with the scale variation. Each condenser has a capacity range from .00002 to .0007 mf. The metal case of this condenser acts as an electrostatic shield and should be grounded as shown in the circuit diagram. C_3 is a fixed condenser with a capacity of .002 mf. and may be made with mica as a dielectric. Fixed condensers marked X have a capacity of .0005 mf. These also may have a mica dielectric.

The use of an amplifier is optional, but it is desirable in many cases where trans-Atlantic signals are to be received on a small antenna. With a two step amplifier, at my station, signals have been copied from the Nauen station in Germany *without aerial and ground connection.*

In operation, the receiver is wired exactly as shown. To operate, the filament is lighted, slider "S" moved near the negative end of the resistance P, inductance L_2 placed at a distance of 2" from L_1, L placed 3" from L_1, and the condenser C_1 varied over its entire range. If no resonance clicks are heard in the telephone receivers during this operation, reverse the leads connected to the terminals of L_2. Clicks will now be heard if all the instruments are connected as they should be. Such clicks indicate the presence of oscillations in the closed circuit and occur at the point where the primary is in tune with the secondary circuit. If there are two clicks widely separated, reduce the coupling between L and L_1 until just one click is heard. Also loosen the coupling between L_1 and L_2 to the point where it is just possible to maintain oscillations. When the proper adjustment for S is obtained, the distance between L_1 and L_2 may be as much as 6" to 8". For weak signals this last mentioned adjustment is best and needs only to be changed slightly for the entire range of wavelength.

The set is now ready for reception. To locate a station it is only necessary to vary C_2 and follow it up as indicated by the click from C_1. If the couplings between all three inductances are always fairly loose the settings for a station of any given wavelength will always be the same.

The fixed condensers, X, X, etc., may give place to variable condensers having a maximum capacity of .0025. In this case, adjustment for wavelengths below 7,000 meters will be somewhat critical.

Third Prize—A Long Wave Amateur Receiving Set

MANY amateurs have the impression that during the summer months receiving is difficult if not impossible due to the static which is so troublesome at this time of the year. This is to a certain extent true, but not nearly so much so as is generally believed. In fact it is very seldom that the static gets so bad that the high whistling tone of the undamped wave stations cannot be heard, and quite a thrill is experienced when they are first tuned in as the sound is unlike any ever heard before.

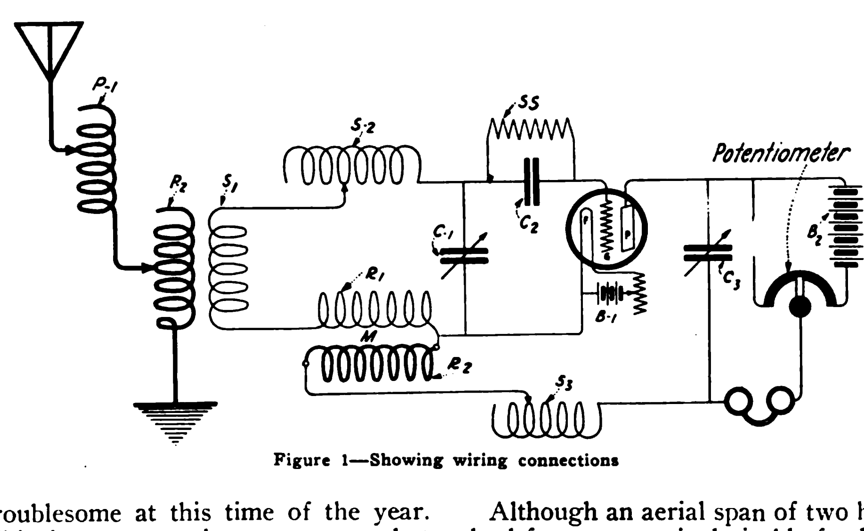


Figure 1—Showing wiring connections

Although an aerial span of two hundred feet or more is desirable for long wave work, it is not necessary. In fact the author finds little difference in the readability of signals on a 400 foot aerial and one sixty feet long.

With reference to the apparatus itself the connections as shown in either figure 1 or figure 2 may be used, figure 1 being somewhat better. The coil P-1 is the primary loading coil and may be wound with number 28 wire. The winding should be about 30 inches long on a tube about 5 inches in diameter. The primary coil P-2 should be wound with the same size wire as coil P-1 and should be 12″ long and 6″ in diameter. It should be closely variable, the slider being about

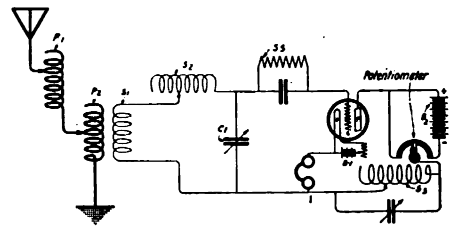


Figure 2—Modified circuit

the simplest method. The secondary S-1 should be about 12″ long and about 5″ in diameter, and should have 16 or 18 taps. This coil should be mounted so as to telescope into P-2. Secondary loading coil S-2 may also be wound on a tube 5″ in diameter with No. 34 wire and should be 36″ in length. S-3 is identical with S-2. The primary R-1 and the secondary R-2 of the regenerative coupler M should be made so as to telescope like a loose-coupler. No set size need be used for this coupler and any old loose coupler may be used if it is not convenient to construct one. A good size for one is: Primary 6″ diameter by 6″ long wound with No. 28 wire, no taps. Secondary 5″ diameter by 6″ long wound with No. 28 wire, no taps.

The long coils should be tapped every two inches or so. Loops may be run through the walls of the tubes and then brought out to switches in a convenient place. This makes it unnecessary to break the wire from start to finish.

It is a rather difficult matter to wind the longer coils entirely by hand but if the builder will use a little ingenuity an arrangement can be worked out which will materially lessen his difficulties. Using a winder made from an old scroll saw the author once wound a coil 20″ long and 5″ in diameter in fifteen minutes. If access can be had to a lathe the coils may be wound in a short time.

In practice the three coils P-1, S-2 and S-3 may be of the same dimensions and No. 30 S. C. C. wire used throughout. Only one section of each coil need be tapped as the other sections of the coil may be cut either in or out and the tuning done with the tapped section. This is clearly indicated in figure 3. For any variation up to one full section set the switch B on point C and tune with switch A. For variation up to 2 coils and over one, set switch B on point D and tune with the switch A, etc., etc. Such an arrangement saves quite a lot of time and labor and is just as satisfactory as having the whole coil tapped.

No very definite sizes and dimensions are given above for the apparatus described. The builder will be able to meet the requirements from materials which he has at hand.

The variable condensers C-1 and C-3 may be either the large or small types well known to all amateurs. A large one is better for C-3. The condenser C-2 may be made of mica coated on each side about 2″ by 4″. A small variable condenser may be substituted. No bridging condenser is needed across the receivers although one may be used if desired.

A potentiometer is shown for the "B" battery regulation, but a switching arrangement may be used. Another feature of these connections is the grid leak "SS." This may be made of a piece of fibre about 1″ long and ½″ wide with a binding post at each end. It is connected in shunt to the grid condenser and a pencil line drawn between the posts. If the static or incoming signal is so strong that it paralyzes the bulb the "plugging" can be prevented by running a pencil between the posts until it stops. A line ⅛″ in width is about right.

The circuits are adjusted for oscillations by using very close coupling

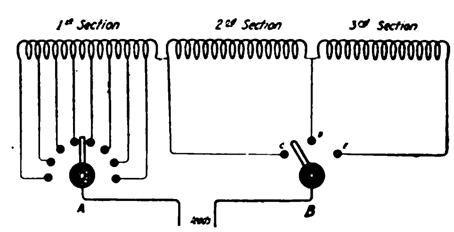


Figure 3—Method of tapping the coils

at M, and adjusting S-3 and C-3 until a click is heard both when the finger touches and leaves the grid binding post. This double click is an indication that the circuits are oscillating. The primary circuit is now brought into resonance with the closed circuits. By keeping these circuits more or less in resonance, and varying their wavelength, any undamped wave-stations which may happen to be sending will be heard. The undamped wave stations are in operation at practically all hours of the day, and consequently may be heard at practically any time one may care to listen.

A modification of the circuit described above is shown in figure 2, where no regenerative transformer is used, and where the coupling between the wing and grid circuits is provided by the capacity of the telephone cords.

JAS. B. HOLSTON—*Nashville, Ills.*

Vacuum Tubes in the Army

THE radio experimenter who has not been in touch with the work of the Signal Corps during the war will be interested to learn of the progress made in the construction of the vacuum tube during the past two years. Prior to the closing of the amateur stations this device was used by the more advanced experimenters, but only for the receiving purposes, and at its best it still had certain defects.

Skilled engineers from several of the largest electrical companies have improved the vacuum tube from the make-shift device of two years ago, to one of the most useful and efficient instruments known to radio communication. The standard tube applied to the Signal Corps for receiving purposes has a number of features which are a distinct advance over any tubes the amateur has had access to, and in addition a transmitting tube of considerable power has been developed, and in such quantities that it should be obtainable at reasonable cost.

The standard receiving tube operates on the usual 4-volt filament battery and 40-volt plate battery, but it has operating characteristics much better suited for its use by inexperienced operators. No critical adjustments of either the filament current or the plate voltage are required, the tube being designed so that it is operative over a 20 per cent. variation in these values. Thus, the filament rheostat and plate potentiometer are eliminated, which is indeed a marked improvement. Again, the same tube will function equally well as a detector, amplifier, or oscillator, making it unnecessary to select different types of tubes for each specific purpose.

As an amplifier, the amplification constant ranges from 12 to 25 and two such tubes connected in cascade will give amplifications in the neighborhood of 500. It has been found, however, that a cascade circuit of more than three steps again introduce the unstable conditions of the earlier tubes, and to overcome this, resort was had to an ingenious device. The signals were amplified at radio frequencies for three steps, then a detector tube was introduced, and from its output circuit, the signals were again amplified three times, at audio frequencies. Using this combination of seven tubes, it is possible to obtain an increase in signal strength up to the current saturation of the tube. For such an amplifier 60 volts are required in the plate circuit, and 4 volts, 7.7 amperes for the filament.

Experiments were also carried on with the object of producing tubes that would require a minimum battery equipment. The engineers finally succeeded in designing some that require 0.2 ampere at 2 volts for the filament, and other tubes which operate efficiently with from 4 to 6 volts in the plate circuit. What a boon these tubes would be to the average amateur who is troubled with the question of adequate current supply?

The transmitting tube which was adopted as standard for our army in the field, was more difficult to design than the receiving type, but it shows the results of careful engineering. It requires 7 volts for the filament, and 250 to 350 volts for the plate circuit. It has an output of from 3 to 5 watts high frequency power. It found a wide application on the small airplane transmitters, and was also used as an amplifier tube in the receiving circuit where a greater power output was required.

Transmitting tubes of much higher powers have been designed for experimental purposes, one of which had an output of 30 watts high frequency current, and required a plate voltage of 800. Another had an output of 100 watts, with a plate voltage of 1,500, but it is unlikely that such tubes will ever find a wide application in the amateur field, owing to the difficulties attending the production of the high voltage current.

Much credit is due to the engineering experts who have achieved such remarkable success in this work of developing the vacuum tube.

Queries Answered

Answers will be given in this department to questions of subscribers, covering the full range of wireless subjects, but only those which relate to the technical phases of the art and which are of general interest to readers will be published here. The subscriber's name and address must be given in all letters and only one side of the paper written on; where diagrams are necessary they must be on a separate sheet and drawn with India ink. Not more than five questions of one reader can be answered in the same issue. To receive attention these rules must be rigidly observed. Positively no Questions Answered by Mail.

O. E. S. Stanwood, Wash.

See answer to E. J. W. in this issue.

In the June issue of THE WIRELESS AGE, page 29, second column, the fifth line from the bottom, the word "each" should be omitted so that the line will read "a tap placed at 55 turns." Turn fifty of section 1 and beginning of section 2 are connected and form tap 1. Tap 2 is at 55 turns on section 2 or 105 turns total. Tap 3 is at end of winding. The 3/8-inch space is left to reduce distributed capacity on the lower wave lengths.

Figure 6, page 29, June WIRELESS AGE, have the numbers 5 and 7 erronously transposed in the winding diagram.

* * *

E. J. W., Roxbury, Mass.

See reply to O. E. S. in this issue.

The coil you wish to use is wound with Litzendraht and No. 18 D. C. C. wire on a tube 3 inch outside diameter. A four banked winding is used as shown in figure 6, page 29, of the June issue. A section of fifty turns is wound on the spool and a space of 3/8 inch is left after which another section of 240 turns is wound on with the tap placed at 55 turns.

In the next to the last paragraph, page 29, the word "each" before the number of turns, should have been omitted.

* * *

P. A. H., Pawtucket, R. I.

The diagram shown on page 41 of the July WIRELESS AGE is incorrect in that the wire running from the 20,000 ohm resistance to the double pole double throw switch should not be shown as connecting to the ground lead.

* * *

M. W., Troy, N. Y.

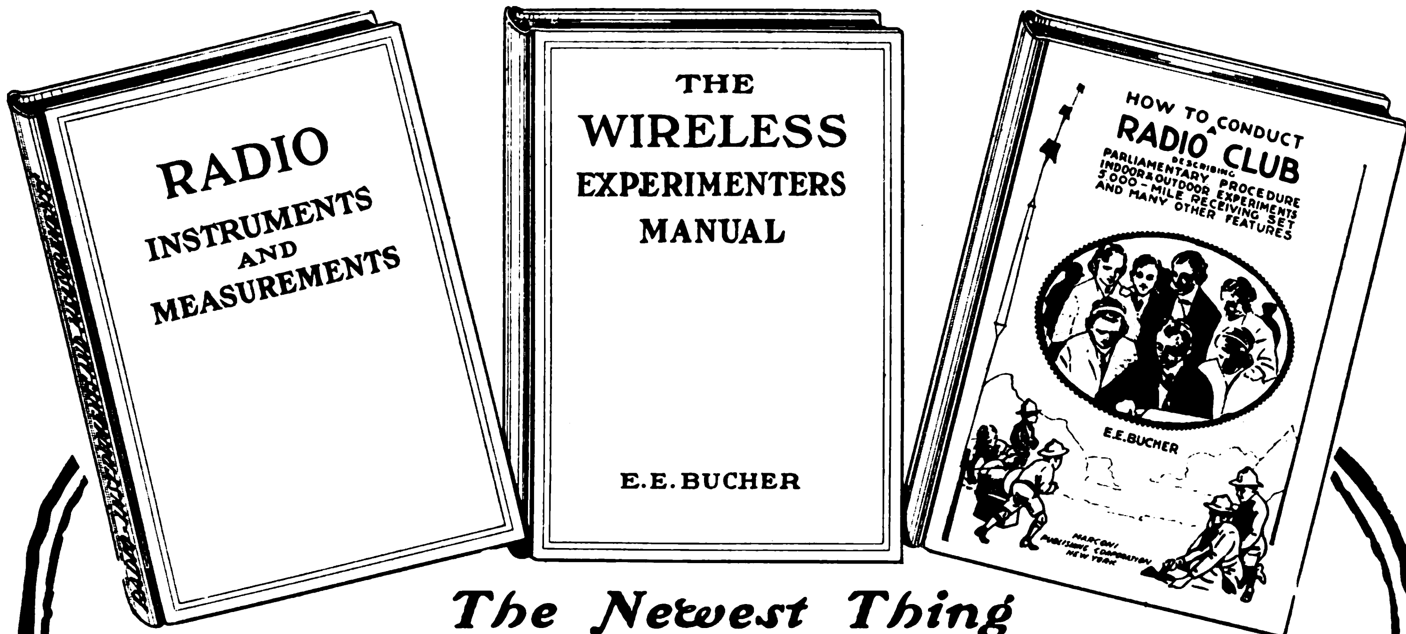
Satisfactory results for calculations such as yours may best be obtained by the use of Nagaoka's formula (see August, 1915, issue), rather than Cohen's. You seem to have failed to convert your dimensions into centimeters in all cases. The inductance of a coil 4 inches in diameter by 1 inch in length wound with a single layer of 30 turns is approximately 125,000 centimeters.

From dimensions given in figures on page 27 of the May issue, you will yourself be able to calculate the various inductances which go to make up the receiver there described. In the case of the ball, it may be considered as a cylindrical winding 2¼ inches long and having a mean diameter of 3 15/16 inches, the spacing in the center being disregarded. Each pair of field frames may be treated in like manner. Your results will be sufficiently accurate for all practical purposes. If you use No. 32 wire throughout the secondary circuit of your receiver, its efficiency will be considerably decreased since resistance rises rapidly at the higher frequencies. Otherwise the receiver should operate in a very satisfactory manner.

* * *

W. G., New York City.

See article to appear in October issue on "A Two Stage Amplifier Cabinet."



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A-9-19.

H. H., Atlantic City, N. J.

Cells of the "A" and "B" for the vacuum tube detector you mention should be in series.

Castor oil may be used in a condenser to increase the capacity of the condenser, the specific inductive capacity of castor oil being between 4.5 and 5 times that of air. Other oils, such as lubricating oils of various qualities, may be used. A particular good grade of oil which may be used in the case of transmitting condensers, is "Nujol," which may be purchased at any drug store.

The newspaper clipping which you enclose, refers to a loop aerial, but a coil such as you have mentioned, that is No. 18 copper wire wound on a frame 1 ft. square and 7 feet in length, would not make a good one. It would be better by far to make a frame 7 feet square and 6 or 8 inches in width.

An article will be published in this magazine in the near future on loop construction and the use of the loop for transmission and reception.

* * *

H. W. N., Victoria, B. C.

A fairly complete list of high power arc and spark stations with their wavelengths, is being published in this issue.

* * *

R. W. P., Detroit.

As Mr. Dean gave no dimensions for the condenser test tubes which he described in the November, 1916, issue of WIRELESS AGE, it is impossible for us to say exactly what the capacity of the condenser would be. You will be safe, however, in figuring that it is somewhere in the neighborhood of .0003 mf.

* * *

M. B. DeL., Annapolis, Md.

The limits of amplification using three electrode vacuum tubes, vary with the type of coupling used between the tubes and the precautions taken to prevent extraneous and undesirable back-coupling, be it either electrostatic or electromagnetic, between the first tube or tubes in the circuit and later tubes. After a certain amount of voltage amplification has taken place, electrostatic or electromagnetic fields are set up due either to the concentrated windings of the coupling transformer or to the wiring, and sooner or later these stray fields will link the fields having to do with the wiring, or transformer of the first tube and oscillations will result. These oscillations are uncontrollable under these conditions and consequently the amplifier is no longer useful. With proper methods of shielding the various stages of the amplifier from these undesirable fields amplifications of the order of 100,000,000 times have been effected. With the ordinary methods of coupling tubes and where no effort is made to guard against magnetic and electrostatic fields existing in them, the order of amplification reaches a limit somewhere around 1,500 times.

The action taking place in an arc transmitter after the striking of the arc and up to the time when steady oscillations begin, results in a hissing, sputtering and bubbling noise in the telephone receivers at a station which is in tune with the arc transmitter. This hissing, sputtering and bubbling is due to the very rapidly changing conditions present in the arc chamber when the arc is struck. The arc will not act at all steadily until that time when the exactly proper atmosphere has been attained in the arc chamber. The nature of this atmosphere depends upon the temperature and upon the amount of alcohol which has

passed into the vaporizing chamber from the supply reservoir. During this period of adjustment the arc is at all times endeavoring to supply oscillations, but due to lack of proper temperature, or as above stated, the proper mixture in the chamber, the oscillations are choked out, etc., until finally the temperature having reached the normal operating valve and the proper mixture having been attained, steady oscillations commence.

The modulator member of a two-tube radio telephone outfit acts simply as an amplifier of voice currents passed into the microphone. These voice currents, after having been amplified, are superimposed upon the radio frequency oscillations of the oscillating member of the outfit.

* * *

R. Y., Toronto, Ont.

While a vacuum tube is oscillating there is not necessarily any sound in the telephone receivers, but if while oscillating, a finger is touched to the grid terminal of the receiver and removed again, a click will be heard in the telephone receivers both when the finger touches the terminal and when it is removed, but if the receiver is coupled to an antenna, the characteristic note of spark signals or static will be changed to a hissing, scratchy note. Inasmuch as there is usually more or less static of one character or another, this serves as a fairly reliable indication.

The loose coupler which you describe has a calculated primary inductance of about 45,000,000 centimeters and a calculated secondary inductance of about 75,000,000 centimeters, which being the case, you should be able to receive wavelengths up to 15,000 or 16,000 meters provided your secondary was shunted by a maximum capacity of .001 mf. and provided your antenna was of sufficient size, or a loading inductance was used to make up for what the antenna might lack.

The hook-up which you enclose is not considered the best hook-up for undamped wave reception, due to the fact that the control of the oscillations generated by the vacuum tube is not what it should be. You will find articles in the September issue which will give you preferred schemes of connections, with which you should be able to receive any of the Trans-Atlantic stations on an 85-foot antenna.

It is difficult to say which vacuum tubes are the most sensitive inasmuch as they vary considerably in sensitivity. You will probably find your tubular audion to be as good as any.

* * *

K. E., Seattle, Wash.

If you have in mind the construction of a receiver such as described by Mr. Jones in the June issue, it will not be as satisfactory to wind the inductance in five layers, and not advisable in any case unless the wire is wound on in banks. We suggest that you refer to articles being printed in the September issue, covering construction of long wave receivers, if you desire to build a receiver which is more compact than the one above mentioned.

The comparative values of inductance in the primary and secondary circuits will depend entirely upon the antenna used; that is, its size. For the average 200-meter amateur antenna, the inductance values in these two circuits will run about the same, excepting where a shunt condenser is used in the primary circuit under which condition the primary inductance would not need to be as large as the secondary inductance.

There is no limit to the maximum wavelength which you can tune up to with a 100 foot antenna such as you describe.